THE

ELECTRICAL REVIEW.

VOL. XLIX. OCTOBER 18, 1901. No. 1,247.

CONTENTS:

	PAGE
Facilities for Travel in London	617
Standards in Engineering...	618
Glasgow International Exhibition.—XIII. (*illustrated*) ...	619
Electric Equipment of Cranes (*illustrated*) (*continued*) ...	621
Mathematics and Physics at the British Association	622
The Sutton and Howth Electric Tramway	623
Breakdowns of Electrical Machinery	624
Motors Vehicles and Electricity Works	624
Correspondence:—	
Examination Test for Electrical Engineers	625
Continuous Current Dynamos	626
The Purchase of Foreign Machinery	627
Coal Consumption per Unit in Traction Stations	627
Consulting Engineers as Arbitrators	627
Johnson-Lundell Electric Traction Company	627
Electric Welding	627
Electricity *v.* Other Illuminants	627
Legal	627
Business Notes	628
Walthamstow Electricity Works (*illustrated*)	634
Electric Light Fittings (*illustrated*)	637
Supply Station Accounts	642
City Notes	643
Traffic Receipts	646
Stocks and Shares	646
Share List of Electrical Companies	647
Market Quotations	648
The International Engineering Congress of 1901:—	
Modern Commutating Dynamo Machinery (*illustrated*) (*continued*)	649
Requirements of Electricity in Manufacturing Works (*concluded*)	650
Loss in Economy by the Inefficient Combustion of Fuel (*illus.*)	652
The Automobile Club and Electromobiles	653
Tramway Power Calculations	654
Recent Tramway Practice...	654
New Patents	656
Abstracts of Published Specifications	656

THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

***7s. 6d.*, POST FREE.**

H. ALABASTER, GATEHOUSE & CO.,

4, Ludgate Hill, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON, E.C.

Telegraphic Address: "AGEEKAY, LONDON." Code, A B C.

Telephone No. 933 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades,

AND HAS

BY FAR THE LARGEST CIRCULATION

of any Electrical Industrial Paper in Great Britain.

SUBSCRIPTION RATES.—In Great Britain, Post Free per Year, 19s. 6d. To all other countries, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. Paris: VEUVE J. BOYVEAU, 22, Rue de la Banque. Berlin: ASHER & Co., 13 Unter den Linden.

Cheques and Postal Orders (on Chief Office, London), to be made payable to Mr H. ALABASTER, 4, Ludgate Hill, E.C.

FACILITIES FOR TRAVEL IN LONDON.

IN a letter written by Mr. C. A. Pullman, and published in the *Times* of the 11th inst., comparisons are made between the facilities for rapid transit in London and those in Chicago, much to the disadvantage of the former. Anyone who is acquainted with the conditions existing in London, New York, Boston, and Chicago, not to mention other American cities, is bound to acknowledge that Mr. Pullman's statements are largely true, and that London's facilities for rapid transit are almost conspicuous by their absence.

It must not be forgotten, however, that American cities are of comparatively recent origin and growth, Chicago itself being only about 30 years old (dating from the fire), and that, in consequence, there have been no old traditions to break down or ancient customs to alter. Even after allowing for this we are bound to admit that the average American is much more "go-ahead" than the average Englishman, and generally gets the thing done while the latter is thinking about it.

Happily, however, there is every indication that London is awaking to a sense of its needs in the matter of quick and ready communication between its various parts. The London County Council is, as Mr. Pullman states, fully alive to the urgency of the situation, and its Highways Committee is said to be grappling with the problem as rapidly as its limited powers will allow.

Mr. Pullman touches the spot when he says that what is wanted is that the London County Council, or some similar central body, should have full and complete control over all the public highways in the Metropolitan district. At the present time the County Council is the tramway authority for the County of London, but not the road authority. Consequently, it has to obtain the consent of the various local authorities through whose districts any proposed tramway will pass, before such tramway can be constructed.

Until recently the County of London consisted of over 40 vestries and boards. Under the new Act these have been amalgamated and re-arranged into some 29 boroughs. Each of these boroughs is the road authority for its own district. The London County Council, as the tramway authority, may, in the interests of London as a whole, promote a Bill for certain tramways. It is also true, though, that not only may any of the boroughs through which the proposed tramways are to pass, be heard in Parliament against the Bill, but unless the County Council can previously obtain the consent of two-thirds of the local authorities affected, it cannot even proceed with the application for powers. So long as this state of things exists, it will be impossible to obtain any comprehensive and interconnected system of tramways such as our American friends are familiar with.

Both in Boston and in New York, where the transit question has become of great importance, "transit commissions" have been appointed by the State, with full

powers to deal with the matter. In Boston an excellent system of subways has been the result, and both the surface and the elevated cars run through. The relief to the ordinary street traffic has been most marked, and the system is now being extended by a tunnel under Boston Harbour to East Boston.

In New York the "Rapid Transit Commission" is now engaged in constructing several shallow tunnels, through which an express service of cars will be maintained. The enormous amount of up and down town traffic to be dealt with in New York may be imagined, when it is realised that several of the main north and south avenues will soon have three systems of electric transit, viz., the shallow subway, the surface, and the elevated roads, all in operation together.

The importance to London, as a whole, of a means of rapid transit to all parts is so great that Parliament should give powers to some central body to deal with the matter. It should not be possible for any local borough to block the way, since the welfare of London, as a whole, is of more importance than the welfare of any particular district. Given the central authority and the powers to act, there will be no difficulty in finding the man to do the work.

STANDARDS IN ENGINEERING.

There seems to be a peculiar perversity in manufacturers. Much is said about standardising, yet even in articles that can most easily be standardised, we find this is not done. Let us mention wrought-iron or steel pipe—an article of common use among power engineers and electrical engineers generally.

There is a standard for pipe threads as for bolts, known as Whitworth's. Except for the sizes below about 1 in. inside diameter, all pipes have 11 threads per inch. We believe as regards the number of threads all British makers are in agreement. There are, however, other important dimensions.

Pipes are rated by their nominal inside diameter, but we believe they are only found to be of their nominal diameters when of the lightest scantling, that is, when they are "gas" pipes. Water pipes of the same nominal size are of less inside diameter, steam pipes are still less, and hydraulic and artesian driving pipes still less again. The reason of this departure from nominal sizes is that all pipes are made of the same external diameter, and all addition scantling is put into the inside of the pipe, and so reduces its internal diameter. There are the best of reasons for this. It enables all pipes to be exactly the same outside diameter, both in the body and upon their screwed ends. Pipes of every degree of strength will thus screw together—a most important qualification that must frequently have appealed to engineers, up-country or in the bush, who have had to carry out work with job lots of tube. This Whitworth standard pipe is made to our knowledge by the well-known firm of Jas. Russell & Sons. Other firms also make to the Whitworth recognised diameters on the thread, but there are some pipe makers who do not make to standard. We believe the idea of not making to standard has some basis in the false belief that customers will be thereby retained. We believe the idea to be a fallacy. Think of the position of a man in the bush with two lots of different pipe to put together. If he is short of a bend he can fossick about until he finds some sand and he can dry this in the sun, or by means of a fire, and he can fill a piece of pipe with sand and plug the pipe ends with wood, or may be with grass, and he can heat that pipe in a wood fire and bend it round stakes or by pressure round a tree or a rock. But what can he do with a pipe end that drops loose into the only available socket or **T**-piece. Simply nothing satisfactory. The fit is too tight for decent wooden wedges to be driven in. If there is time to allow it to harden, and any good Portland cement is available, he may mould a big block of cement over the two pipe ends to be joined, or may laboriously burn a hole through a log of wood, and drive it tightly on the pipes as a socket joint. But these troubles should never arise. All pipe makers should unite to insist on the Whitworth gauge. But we know no maker who lists standard pipe above 4 in. We believe there is no Whitworth pipe standard for larger sizes than 4 in., though the threads per inch are 11 in number for all sizes to 24 in. diameter or upwards, because any coarser thread would cut too much into the body of the pipe to be safe. Yet pipes of 6 and 8 in. and larger are employed by power station engineers and no one seems to know their sizes. An 8-in. pipe will no doubt have an outside thread diameter of 8½ in., but there is no standard recognised. Neither is there a standard pipe flange for steel or wrought-iron pipe. There is no standard diameter, and no standard number of bolts, or bolt circle pitch, of angular position of bolt holes, or bolt diameter.

Further, much work has been done in this country with American pipes. If any engineer brings in American pipe, he ought at least to see to it that it is to Whitworth standard. The American thread of eight per inch is a bad thread. It is too coarse a pitch for the good of the pipe, does not readily make steam-tight joints at the flanges, and has been a source of endless trouble and difficulty. This question of standard pipes and flanges is one that might well be taken in hand by a committee of the Institution of Mechanical Engineers. It would seem a good rule that the number of bolts should be even, that it should not be less than four, and should exceed the number of inches diameter of pipe by 2. Thus a 4-in. pipe would have six bolts, a 6-in. pipe eight bolts. Another rule would be to use one bolt each inch of pipe diameter. There are probably no better proportions than those adopted by the Brush Company. We do not know how they originated, but they are good practice. We may add that a bad standard, if safe, is better than confusion. It is high time that pipes were all made to one recognised standard, and that this should be extended to the sizes beyond the present tabular limit of 4 in. only.

The L.C.C. and Electric Traction.—In the course of his address on the work of the Council during the past year, Mr. A. M. Torrance (chairman of the Council) made the following remark:—"The Highways Committee has vast schemes in progress and under consideration. It aims at revolution. It will not rest content until every district in London is properly served with tramways. It is convinced that horse traction is doomed, that electricity must be the future power, and that the conduit system must be adopted."

GLASGOW INTERNATIONAL EXHIBITION, 1901.

XIII.

THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LIMITED.

Presumably preferring freedom and fresh air to the restrictions and stuffiness of the Machinery Hall, the British Westinghouse Company has built a handsome Pavilion in the North Gardens for the accommodation of its extensive and varied exhibits. The photographs which we reproduce herewith, while hardly doing justice to the exhibits, on account of the difficulties involved in photographing interiors, serve to indicate the scope of the show.

PART OF THE WESTINGHOUSE EXHIBIT.

One of the most interesting exhibits is a Westinghouse three-cylinder vertical gas engine of 125 H.P., which is direct coupled to a dynamo supplying power to all the plant at work in the Pavilion. The gas supply is derived from the Corporation mains, and is, therefore, illuminating gas. As the crankshaft receives an impulse for every two-thirds of a revolution, the Beau de Rochas cycle being used, and runs at a high speed, a comparatively small fly-wheel power suffices to maintain regularity of rotation. The governors operate, not by cutting off the gas supply alone, but by varying the quantity of the explosive mixture admitted to the cylinder at each cycle, so that there is an explosion of greater or less intensity in each cylinder at every fourth stroke. It is claimed that this engine runs silently, at uniform speed, occupies small floor space, is self-starting, and highly efficient.

The dynamo is a compound-wound railway generator of the Westinghouse Company's standard pattern; it is mounted on the same bedplate as the engine, and the armature is pressed on to an extension of the crankshaft. The field magnet is of the multipolar type, of the graceful shape characteristic of the company's machines, and is divided into two parts in the vertical plane; the separate halves can be drawn apart on guides to give access to the armature and field magnet windings. The series and shunt coils are separately wound on formers before being placed in position on the poles.

The armature is built up of soft steel discs on a cast-steel spider; the conductors are copper bars forged to shape, laid in slots in the periphery of the core, and secured by hard fibre wedges. The commutator is also carried by the same spider, and is built of hard drawn copper bars insulated with mica. The armature is well ventilated, and, like all the larger Westinghouse generators, is provided with equalising connections joining together certain points of the armature windings which are at the same potential; to this device is largely attributed the cool and sparkless operation of these machines.

The dynamo works at a pressure of 125 volts, and is connected with a switchboard of standard type consisting of five panels, whence two main circuits are led. One of these feeds a direct current motor-generator, consisting of two standard machines coupled together on one bedplate; this set raises the pressure to 500 volts for the purpose of driving a 325-KW. shunt-wound generator as a motor. The latter is built on the crankshaft of a vertical compound steam engine made by Messrs. Markham & Co., of Chesterfield, which is driven by the aforesaid motor.

The other main circuit feeds a rotary converter of 50 KW. output; this converts the direct current to two-phase alternating current at 400 volts, 60 cycles per second, which is used for driving a two-phase type C induction motor of 10 H.P. capacity, and for other purposes.

It is noteworthy that the Westinghouse polyphase induction motors are not provided with slip rings on the rotor for starting. In the smaller sizes, of course, they can be started without any special device, but the larger motors are started with a reduced voltage on the stator, which is obtained by means of an auto-transformer, or, in certain cases, with a four-wire two-phase supply, by means of an alteration in the connections.

The 10-H.P. induction motor is coupled by belt to a direct current generator of the same rating.

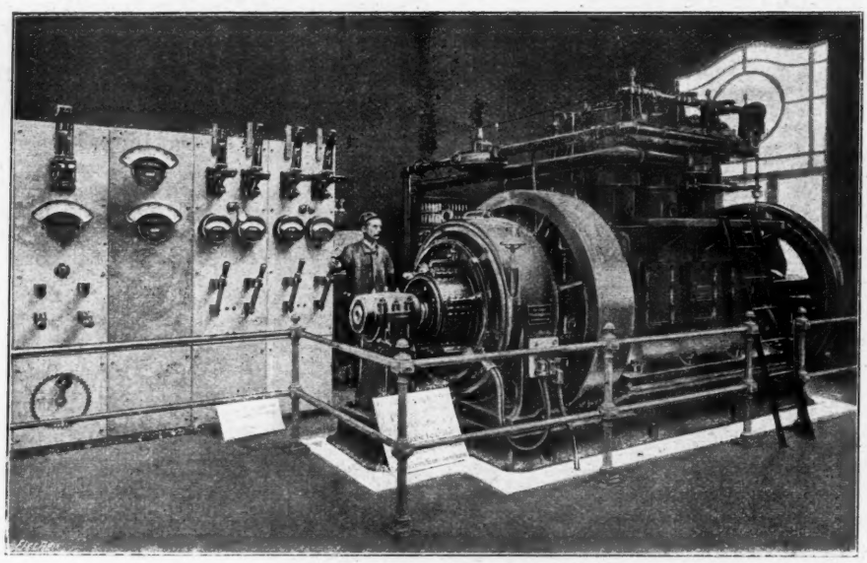
Part of the two-phase current is used for carrying out various experiments illustrative of the properties of polyphase currents.

POLYPHASE AND DIRECT CURRENT MOTORS, &c., DISSECTED.

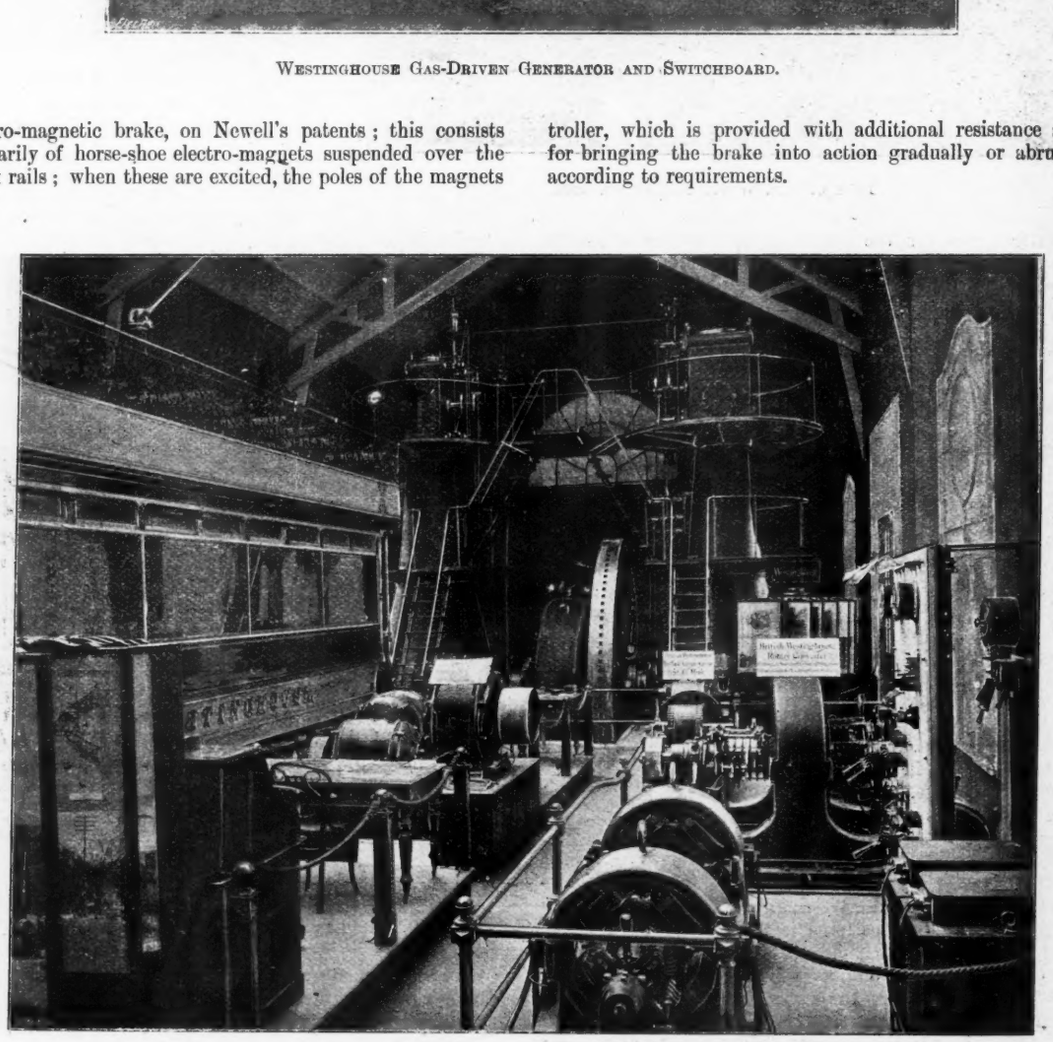
A striking feature of the exhibit is a complete electric tramcar made by Messrs. Milnes & Co., of Birkenhead, and equipped with Westinghouse motors, controllers and brakes. The motors are of the 49 B type, specially designed for low speeds and frequent stops and starts, such as obtain in city service. There are two motors, each driving one axle through single reduction gearing. The fields are of the four-pole type, with laminated poles cast into the yoke. The armatures are of the standard slotted-core type, of small

diameter and light weight, these qualities being found to be most suitable for the conditions of street service.

A special feature of the equipment is the Westinghouse electro-magnetic brake, on Newell's patents; this consists primarily of horse-shoe electro-magnets suspended over the track rails; when these are excited, the poles of the magnets grip the rail, and at the same time bring into action the ordinary brakes bearing on the rims of the wheels. Further, the motors are used as generators to provide the exciting current for the electro-magnets, so that a braking action is exerted on the rails, on the wheels, and on the axles simultaneously. The brake is controlled by the ordinary controller, which is provided with additional resistance stops for bringing the brake into action gradually or abruptly, according to requirements.



Westinghouse Gas-Driven Generator and Switchboard.



General View of the Exhibit.

The car stands on a short length of track over a well, so as to facilitate inspection of the motor and brake equipment.

Other exhibits consist of various motors, generators, &c.,

shown in parts, to enable the details of their construction to be examined, and of incandescent lamps made by the Sawyer-Man Electric Company, which is under Westinghouse control. A large illuminated sign at one end of the Pavilion compels attention to this feature.

The whole exhibit, it will be seen, is highly interesting, and worthy of the well-known company by whom it has been organised.

ELECTRIC EQUIPMENT OF CRANES.

By WILL RUNG, of Baden, Switzerland. Translated by W. PARK and J. LEHMANN.

(*Continued from page* 500.)

Before dealing theoretically with the proper way of dividing up the resistance, we shall consider some of the actions taking place when starting a shunt motor under load.

Let e stand for the back E.M.F. of the motor, C for the current through the armature, W for the power at any moment, then—

$$C = \frac{W}{e}.$$

W consists of two parts, W′ and W″, W′ being the power lost in friction and hysteresis, and W″ the power converted into available mechanical energy. W′ is directly proportional to the speed, and is equal to $K' \times N$, where K′ is a coefficient, and N stands for the number of revolutions per second. Supposing now that the total force acting at the circumference of the armature remains constant during the whole of the starting, it follows that W″, the mechanical power at any moment, being proportional to the speed, is equal to $K'' \times N$, K″ being another coefficient.

The back E.M.F. of the motor, as is well known, depends upon the number of lines of force passing through the armature, the number of convolutions of the armature winding and the speed. Assuming that the supply pressure at the terminals does not alter, the number of lines of force passing through the armature consequently remaining constant, we have—

$e = K''' \times N$, K‴ being a coefficient.

Then the equation gives

$$C = \frac{K' \times N + K'' \times N}{K''' \times N} = \frac{K' + K''}{K'''},$$

that is to say, C = a constant.

Thus during all periods of the starting, the current will remain constant, its value depending on the power required. The assumed conditions, however, would only obtain if the motor were able to instantaneously alter its speed according to the alteration of the resistance. But this is not the case. Let us consider the moment when the motor has just been started, the contact piece, B, being placed on the contact 1 (fig. 6). From the moment when equilibrium has been established the motor will run at constant speed, the back E.M.F. being—

$$e = E - C(r_a + m_1)$$

where E stands for the terminal pressure, C for the current, r_a for the internal resistance of the armature, and m_1 for the value of the starting resistance put in the circuit at the moment of starting. Now, when moving B on to contact 2, the motor will require a certain time to attain its corresponding speed; consequently, on account of the lessened resistance the current will suddenly increase until a certain value C_1 is reached, but will soon again decrease as the speed goes up, thereby raising the E.M.F. Thus at the first moment the E.M.F. will be

$$e_2 = E - C_1(r_a + m_1 - r_1),$$

r_1 being the resistance of the coil between contact 1 and 2. As soon as equilibrium is again attained, the back E.M.F. has assumed a value, e_1, so as to reduce the current to its former value C. At this moment

$$e_1 = E - C(r_a + m_1 - r_1).$$

This process will go on every time the contact piece is moved to the next contact, the current first increasing and afterwards falling to its former value.

If the resistance is not properly divided up into sections, these rushes of current may have rather awkward consequences. If, for instance, the resistance is divided up into a certain number of equal parts, a short calculation will show that the differences $C_1 - C$: $C_2 - C_1$, &c., increase more and more the nearer the contact piece comes to the last

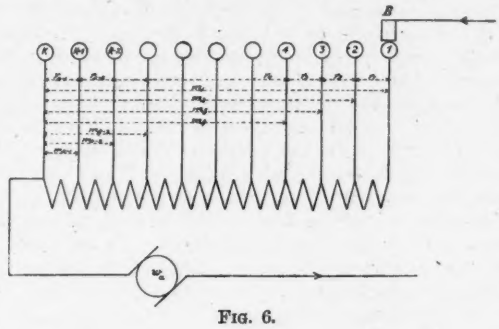


Fig. 6.

contact K, with the result that the contacts, especially the last ones, are eaten away very quickly by the heavy sparking, and also the supply station is subjected to very sudden changes of load; consequently the resistance has to be split up so as to make $C_1 - C$ constant for all the different periods of starting, this value being kept below a certain amount previously fixed upon. To that end, let us suppose the contact B to be touching the last contact but one (No. K − 1); the resistance thus being short circuited except the last part m_{K-1}. When equilibrium has been established we have the E.M.F. =

$$e_{K-1} = E - C(r_a + m_{K-1}).$$

Now, when moving the slider to the last contact (No. K), we have at the first moment the E.M.F. unchanged, that is to say,

$$e_K = e_{K-1} = E - C_1 r_a.$$

These two equations give us :—

$$E - C_1 r_a = E - C(r_a + m_{K-1}).$$

$$\therefore m_{K-1} = \frac{C_1}{C} r_a - r_a.$$

In the same way, when moving the switch from the foregoing contact (No. K − 2) to the last but one (K − 1) we get—

$$E - C_1(r_a + m_{K-1}) = E - C(r_a + m_{K-2})$$

$$\therefore m_{K-2} = \left(\frac{C_1}{C}\right)^2 r_a - r_a.$$

Further we get in the same way :—

$$m_{K-3} = \left(\frac{C_1}{C}\right)^3 r_a - r_a,$$

and so on until, when the whole of the resistance is put in the circuit, the slider resting on contact 1, we have,

$$m_1 = \left(\frac{C_1}{C}\right)^K r_a - r_a.$$

In this last equation the values of m_1, r_a, and C, are known, or have already been decided upon, and thus by deciding upon C_1, or rather upon the variation $C_1 - C$, the corresponding number of contacts K can be calculated, being very nearly—

$$K = \frac{\log m_1 - \log r_a}{\log C_1 - \log C}.$$

From the above calculation it will be seen that the values of the different resistances to be successively put in the circuit so as to make the variation of the current $C_1 - C$, $C_2 - C_1$, &c., constant, form the links of a geometrical progression, the quotient of which is $\frac{C_1}{C}$.

When these values m_1, m_2, m_3, have been duly calculated

as shown, the separate parts of the resistance are found by simple subtraction.

$$r_1 = m_1 - m_2.$$
$$r_2 = m_2 - m_3.$$
$$r_{K-2} = m_{K-2} - m_{K-1}.$$

In the above calculation, the contact called No. 1 is not necessarily the first contact on the switch, but that one on which the contact arm rests when the armature commences to rotate. This contact will depend on the load on the motor at the moment of starting. In a certain instance, say, the motor starts on the fourth contact, the first three contacts, though ineffective in starting the motor, nevertheless prevent too sudden a rush of current through the mains.

By arranging the resistance as above described, the percentage rise in speed of the motor is constant when moving the switch across any two contacts on the resistance. If, for example, r stands for the whole of the resistance put in the circuit at any moment, we have $e = E - C r$, hence it is obvious that e increases after the law of a geometrical progression, when r decreases in accordance with the same law. Now, the number of revolutions being directly proportional to e this number, too, will follow the said law, that is to say, the percentage change of speed is constant.

The case of a series motor is somewhat different, any variation of the current through the armature causing a variation in the total number of lines of force through the pole-pieces. By a similar calculation to that just given for a shunt motor the following result is arrived at:—

$$m_1 = r_a \left(\frac{C_1}{C} \times \frac{Z_1}{Z}\right)^K,*$$

where Z and Z_1 stand for the total number of lines of force through the poles when the currents are C and C_1 respectively. When calculating the other values of the resistances, it is recognised that in this case, too, they form the links of a geometric progression, having the quotient

$$\left(\frac{C_1}{C} \times \frac{Z_1}{Z}\right).$$

When calculating K, $Z \times Z_1$ can be replaced by the corresponding E.M.F. which the motor would produce when run as a dynamo at one revolution per second.

The tracing out of how to divide the starting resistance for a three-phase motor in accordance with the considerations laid down when dealing with a direct current motor, involves a rather complicated and protracted calculation, and therefore will be omitted. Experience has shown that no important error is committed when using in this case also a geometric progression. The number of contacts is decided by experience, and as the sparking is not great the contacts can be made somewhat smaller than in the case of direct current resistances.

As to the mechanical construction, a resistance which is to be put into and out of action times without number during the day, must obviously be of ampler dimensions than a simple starting resistance which is worked a couple of times a day only, and this is a matter of all the more importance if the resistance is to be used for regulating as well as for starting. Therefore it is imperative to provide as large a cooling surface as possible and excellent ventilation; the resistance must to the highest possible extent be fireproof, and when made up with wire spirals, care must be taken to avoid the possibility of their touching each other in the event of shaking. The material for the resistance should have a high specific resistance and the smallest possible temperature coefficient. Thus rheotan, koustantan, German silver, &c., are excellent, but unfortunately rather expensive; several firms use iron on account of its cheapness, this, however, is not to be recommended, for several reasons. Thus drawbacks are found in its very high temperature coefficient, and its liability to oxidise at the high temperatures to which it is frequently exposed. For three-phase working iron is useless, as its magnetic properties increase the self-induction, thus diminishing the starting power of the motor. Nor can liquid resistances such as dilute acid and solution of soda be recommended in connection with crane running, as they require to be regularly inspected, evaporate quickly and are liable to splash about with sudden movements. For the same reasons metal resistances immersed in oil are not advisable.

Before leaving this subject we shall deal briefly with the automatic starting resistances. Occasionally the starting device cannot be placed within reach of the driver, but must be placed immediately at the motor; as, for example, in the case of an elevator, when the current has been switched on, the resistance must then automatically be gradually cut out, and as soon as the current is switched off the whole of it must be put in the circuit again, ready to make a fresh start. When the motor is small it may be made to do this work itself by means of some mechanical arrangement; but in the case of larger motors a wheel gear can be adopted, or better still, a special small motor. With a view to safety, the resistance must be so arranged as to prevent the contacts from moving unless the motor starts itself. Should the motor not start on account of overload or from other reasons, the resistance must automatically remain in the circuit. Such devices exist in a great number of varieties, and it would be beyond the scope of this article to give an account of them in detail.

(To be continued.)

* Given by Ehrens in *Electrotechnische Zeitschrift*, 1899.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

Major Mahon in his presidential address discoursed chiefly on the most recondite departments of mathematics, such as the theory of functions, invariants, combinatorial analysis, and other subjects which are Greek to the ordinary mathematician. As a pure mathematician he had no sympathy with the recent movement in favour of special systems of mathematics for special professions or trades, leaning rather to the well-known professor's idea that the beauty of a mathematical investigation was inversely proportional to its practical value.

His criticisms of the advocates of "Mathematics for Engineers," "Mathematics for Gasfitters," &c., was somewhat severe and scathing. He described such proposals as attempts to construct royal roads to scientific knowledge. The advocates of these views were, to his mind, urging a process of "cramming" for the work of life which compares unfavourably with that adopted by the "crammers" for examinations; the latter, he believed, were, as a rule, much maligned individuals, who succeeded by good organisation, hard work and personal influence where the majority of public and private schools failed. But what could be said for the principle of cramming for the work of one's life? Here an examination would be no check, for examiners imbued with the same notion would be a necessary part of the system; the awakening of the student would come perhaps slowly but none the less inevitably; he might exist for a while on his formulæ and his methods, but with the march of events, resulting in new ideas, new apparatus, new designs, new inventions, and new materials, requiring the utmost development of the powers of the mind, he will certainly find himself hopelessly at sea, and in constant danger of discovering that he is not alone in thinking himself an imposter.

This is a severe indictment of the system of teaching mathematics for a specific practical purpose. No better illustration of the objections to this method could be found than in the recent developments of electrical engineering. Many problems are presented by the later developments which defy the calculating powers of the older school and require the services of men trained in more modern schools. Still, the electrical engineer, like other practical men, has only a limited time to apply to the study of mathematics, and few can hope to attain the ideal mathematical education dreamt of by Major Mahon. Some *via media* has to be found, which, however, might be much nearer Major Mahon's standard than that which is considered sufficient at the present day.

Few papers of great theoretical or practical interest to electricians were read before the sections at the Glasgow meeting. Amongst the most important from a theoretical

point of view was the paper by Dr. Cremieu, "Sur les effets Magnetique de la Convection Electrique." This paper described experiments made by the author to determine the magnetic effect of a moving charge of electricity. The result was not confirmatory of accepted electrical theories, but rather "upsetting." Dr. Cremieu, with his apparatus, could detect no magnetic effect from a moving electric charge; though a belief, founded on the experiments of Rowland, that such an effect could be demonstrated, has hitherto been part of the stock-in-trade of the theoretical electrician. The latest theory of electric current, in fact, explains its magnetic effect on the assumption that the current consists of streams of electrons, *i.e.*, corpuscles or particles of matter, each carrying an electric charge. If Dr. Crémieu's experiment is accepted, it will shake the foundations of present day electrical theory. It is not, therefore, likely to be accepted without the most rigid investigation. The strongest objection brought forward against it was the suggestion of Dr. Wilson that a negative charge was induced in the metal work of the apparatus which screened the effect of the rotating positive charge.

Another contribution of great theoretical interest was Prof. Schuster's paper "On the Conduction of Electricity through Mercury Vapour." Mercury in the liquid condition is, as is well known, a very good conductor, and, on that account, it might be expected that the vapour of mercury would be a fairly good conductor. Theoretical considerations, however, point to an opposite conclusion. The molecule of mercury vapour is monatomic, *i.e.*, there is only one atom in the molecule. Now conduction of the electric current through gases can only take place, according to modern views, by the dissociation of the molecules. The monatomic molecule of mercury cannot be split up, and, therefore, theoretically the vapour of mercury should be a first-class insulator. Schuster's experiments did not quite demonstrate the theoretical conclusion, but he found that a voltage of 1,000 cells was required to send a current through a short length of mercury, and the discharge only commenced at a temperature of 100° C. It was suspected that a much higher resistance would have been obtained if the mercury vapour had been perfectly pure.

Prof. Jagadis Chunder Bose read an interesting paper, in which he described his latest investigations on what are commonly known as "coherers," though the author's former experiments in this field have shown that this name is altogether misleading and inappropriate. He has found that the electric resistance of powdered metals and other substances is not always reduced by the impact of electric radiation; it is with some substances (potassium, iodine) increased. Prof. Bose's theory is that the sensitive molecular layer of each particle assumes a definite allotropic condition with each E.M.F. applied to it, and that the conductivity depends on this allotropic condition. Comparatively slow cyclic variations of E.M.F. have the same effect as rapid electric waves, and in the case of the former he has been able to draw curves representing the relation between current and E.M.F. With substances having perfect self-recovery, the curves of ascending E.M.F. coincide, but with substances having imperfect self-recovery an area is enclosed. There is, in fact, in the latter case a hysteresis. It is to be hoped that Prof. Bose will pursue still further his investigations in this promising field.

Dr. H. A. Wilson, of Cambridge, read a paper on the electrolysis of alkali vapours. His experiments have demonstrated that Faraday's law holds for salt sprays. The salt sprays mixed with air were injected into a platinum tube heated in a furnace to a temperature of 1,400° C. A current was then passed through the vapour from an axial electrode to the sides of the tube. It was found that all alkali salts yield similar current curves, and that these curves become finally horizontal, indicating saturation currents. The sprays are produced by forcing air through aqueous salt solutions.

Darwen.—On Saturday last a new electrical light railway between Darwen and the outlying districts of Hoddleston was opened by the Mayor and Corporation of Darwen. The new railway has cost £13,000.

THE SUTTON AND HOWTH ELECTRIC TRAMWAY.

The Great Northern Railway Company of Ireland has recently opened an electric tramway in County Dublin, which presents several features of interest. As far as we are aware, this is the first example of an electrically-equipped line which has been started by a railway company in the United Kingdom for the purpose of developing its suburban traffic. The tramway, which forms a loop line connecting the railway stations of Sutton and Howth, is worked in connection with the trains on the Dublin and Howth branch, and enables the public to reach the summit of the Hill of Howth by a most interesting and picturesque route. The permanent way is constructed in a very substantial manner; the bullhead rails weigh 72 lbs. per yard, and are carried on cast-iron chairs resting on sleepers placed about 2 ft. 8 in. apart. The gauge of track is 5 ft. 3 in., the same as the G.N.R. main line. The gradients are steep and very continuous, the greatest being 1 in 16·7.

Leaving Howth station, the line crosses the Clontarf and Hill of Howth electric tramway by an iron bridge, and ascends the Hill over ground purchased by the company. The gradient on this part of the line is almost continuously 1 in 20, and in places the line is diverted in S-shape curves, in order to avoid a steeper incline. From the summit of the hill to Sutton, the gradient constantly varies, and for a considerable distance the line runs alongside the main road on a track raised about 6 in. above the road level. Not far from Sutton the line again crosses the Clontarf and Hill of Howth electric tramway, but in this case on the level. From this point to the terminal at Sutton station the track runs through the company's own ground, where the car sheds and power station are situated.

The Power House is a handsome brick building, situated close to the railway line. The three boilers, which work at 160 lbs. pressure, were constructed by Messrs. Taylor & Sons, and are fitted with steam drums in order to ensure the supply of dry steam. The main flue is built above-ground, and the sectional area increases towards the stack, so as to permit of future extensions. The stack is 120 ft. high, and about 8 ft. 6 in. diameter, and contains a firebrick lining built clear of the outer walls. The boilers are supplied with water from a tank raised 17 ft. from the ground by two three-throw pumps driven direct by electro-motors. In addition to these an injector may be used. The tank is fed from a well by a Pulsometer pump and a centrifugal pump coupled to an electric motor. The boiler house also contains a feed heater of the vertical tube type, connected to the exhaust pipe from the engines.

The engines and dynamos are direct coupled, and run at 350 revolutions per minute. There are three machines, each capable of generating 125 KW. continuously. The engines are vertical compound non-condensing, and of the enclosed type. They are supplied with forced lubrication. The complete generating sets, as well as the electric pumps, were supplied by Messrs. Ernest Scott & Mountain, Newcastle-on-Tyne. The dynamos are compound wound, and above each machine is a sliding contact switch for altering the compounding by varying the number of series coils in circuit. A boosting set, consisting of two negative boosters driven by a motor is installed. The field coils of the boosters are separately excited, and the necessary variation in voltage is obtained by regulating resistances. A return feeder (·15 sq. in. sectional area) is connected to the rail at a point about two miles distant, through which the booster draws part of the return current. The boosters are bipolar, and have a capacity of 160 amperes at 100 volts.

The switchboard consists of nine panels supported on a raised platform over a vault containing the various resistances, fuses and connecting cables. There are two positive bus bars, one negative, one equalising, and two boosting bus bars. The various bus bars are put into or out of service by copper screw plugs fitted with ebonite handles. The switches are of massive design; those on the generator panels are interlocked in such a way that the equalising switch must be closed before the main switch. The voltmeters and ammeters are Kelvin instruments. The rheo-

stats are of the rectangular type with sliding contact, and are fixed on a balustrade in front of switchboard.

The Sub-Station is situated at the summit of Howth Head, and contains a battery of 250 Tudor cells, having a capacity of 200 ampere-hours. A second room leading off the battery room contains a reversible booster and several switchboards, which were supplied by the E.C.C., Wolverhampton. The battery is arranged to be controlled from the power house, three miles distant. The booster is used for charging the battery and for discharging in series with the battery, so as to give an increased voltage. The battery switch, the motor-starting switch, and the booster switch are each operated by solenoids connected by underground leads to switches in the power house. By means of these switches the battery can be connected to the trolley wire and feeders so as to discharge into the line and tend to keep up the voltage which would otherwise drop very considerably, owing to the heavy currents taken by cars ascending the Hill.

The Overhead Construction.—A single trolley wire, ·325 in. diameter, is carried over the track by poles with short bracket arms. At passing places centre poles with double bracket arms are used. Each pole also carries short arms supporting porcelain insulators on which a number of hard-drawn copper wires, No. 14 gauge, are suspended. Two of these wires are telephone connections, by means of which communication may be established with the power house from various points on the line. The other overhead wires are pilot wires connecting rail potential voltmeters on the main switchboard with various parts of the rail return. The overhead work was supplied and erected by Messrs. Dick, Kerr & Co.

The Cables.—The positive feeders consist of lead-covered armoured cable ·15 sq. in. area running completely round the hill, a distance of about seven miles. The two ends are brought to separate switches on the main switchboard in the power house. At the battery sub-station the continuity of this positive feeder may be broken, thus forming two separate feeders. At the distances of about a quarter of a mile along the track, fuse and link boxes are placed in brick pits, the manhole covers of which are level with the roadway. The feeder boxes situated at section insulators contain two fuses and one disconnecting link, and at intermediate feeding points they contain a single fuse and link. The boxes are partly filled with insulating compound, and are provided with removable water-tight covers.

The Rolling Stock consists of eight double-decked cars, each capable of seating 67 persons. The cars are carried on double-bogie Brill trucks, each truck supporting a Westinghouse motor. The cars were erected by the British Westinghouse Company. Three types of brake are fitted on each car—the electric brake operated by the B 18 controller of the B.T.H. Company, the ordinary hand brake, acting on all eight wheels, and the Westinghouse air brake. This latter is supplied with air at a pressure of 75 lbs. from two long tubular reservoirs under the car seats. A compressing plant in the car sheds, consisting of two motor-driven air compressors feeding into a large storage drum, is used for charging these reservoirs on the cars.

BREAKDOWNS OF ELECTRICAL MACHINERY.

By CLAUDE W. HILL.

The report on the above subject by Mr. Michael Longridge, a copy of which appears in the *Mechanical Engineer*, is extremely interesting reading, both to users and to designers of electrical machinery.

The causes and nature of the breakdowns are stated as percentages in two tables, and it is surprising to see that mechanical breakages amount to the large figures of 32 per cent. in the case of dynamos and 17 per cent. in the case of motors. The parts subject to mechanical stress are so few in number, and are usually made so strong, that these figures come as a surprise. That such breakages should be more numerous in dynamos is probably due to the fact that an external short circuit throws sudden and violent stresses on a dynamo and does not do so on a motor.

Instances are given of a number of breakdowns, most of which are of that irritating kind due to trivial and easily preventible causes, such as windings burnt out through getting wet, bands broken through being allowed to scrape the fields, motors sparking or burning their armatures through the shunt connection to the starting switch being wrongly made, or not made at all, &c.

The only instances given in detail of mechanical breakdowns are three breakages of shafts. These would convey useful information to designers if particulars were given of the dimensions and arrangement of the shafts.

One of the sources of expense which go to swell the standing charges of a dynamo manufacturer, and so indirectly increase the price of his machines, is the money which has to be spent in sending men to repair damage caused by ill-usage or inexperience.

If an account is sent for such repair work, it is almost invariably disputed and the maker has to give in for fear of the loss of future orders.

The writer would suggest that manufacturers would probably be money in pocket if they were to reprint these reports of Mr. Longridge, and send a copy with each machine, to assist in the education of the attendant.

MOTOR VEHICLES AND ELECTRICITY WORKS.

By W. E. WARRILOW.

The rapid growth of electricity supply schemes into comparatively large undertakings, has brought with it the need of some more speedy method of transit, to meet the demands of the mains department. Lighting areas which extend over many square miles are not easily covered by horse-drawn vehicles, either for the conveyance of the staff (especially in case of breakdowns), or for the cartage of the materials needed on any particular section of work. At the present time the haulage needed on the outdoor work is done either by contractors, or by the Corporation themselves, and of the two the latter is the more speedy, though neither is by any means all that could be desired. The chief causes of this unsatisfactory state of affairs are to be traced to the employment of horses, and the effects their use has upon the driver. The limits of the capabilities of a horse are too well known to need enlarging upon here; suffice it to say, that this otherwise excellent quadruped is fast becoming unsuitable for the speedy haulage of heavy loads. Now, the driving of an ordinary cart horse is such a simple matter, entailing little thought or judgment, that the driver becomes a mere machine, holding the reins and guiding the animal. This simplicity may be desirable in many cases, but in the present instance it produces a stamp of man who detracts from, rather than contributes to, the success of an undertaking. The qualifications of a driver are so small that any man is picked up to do the work, many such men being unable to either read or write. A circumstance in question will serve to illustrate the former deficiency in a carter. A man was told over to remove a load of dirt from a certain street off a main thoroughfare, the fullest instructions being given him as to the whereabouts of the spot. Subsequent inspection found the soil still unremoved, the carter having failed to put in an appearance. On being questioned the following day for his failure to comply with orders, he pleaded as an excuse that he could not read, and was unable to decipher the name of the street to which he was directed. Such an example (which came under the writer's notice), may be rare, and it is hoped that this is the case, though little improvement can be effected while the present artificial conditions obtain. What is seriously needed is the introduction of a system of propulsion which will awaken the drivers to the sense of their responsibilities and necessitate constant watchfulness on their part while at their work. A man in charge of a motor vehicle could scarcely get drunk on duty and expect his machine to go along as usual, though the ordinary horse driver will get drunk or

sleep at his work, because he knows that his horse will need very little guidance on his part. The demoralising effect of such conditions on men who are constantly employed as carters may easily be imagined, while the consequences of such a state of things to the undertaking may be equally well realised. Now, the advances made in the construction of motor vehicles have been so marked in the last year or two that they cannot well be overlooked, especially by engineers holding control over large electric supply undertakings. It is a noticeable feature of all such schemes that particular attention is paid to the provision of up-to-date and efficient machinery at the generating station, with a view to reducing the costs of production, while equally important matters on the outdoor department are oftentimes neglected. It is not advisable that any one section of an electricity supply scheme should be sacrificed for the benefit of any other section, a uniform rate of progress being maintained as far as possible in all departments.

Among the apparently forgotten items, especially on large works, is the question of the cartage of material to and from those districts where large extensions of cable are being laid. The opening of a few miles of trench is not accomplished without the constant plying to and fro of a number of carts, some for the removal of superfluous soil, others for the shifting of stores, and others for the supply of the cable, troughing, bitumen, &c., necessary to carry on the work. The cartage of heavy drums is usually effected by means of a float, though in some cases a cable trolley is used taking up to the largest size likely to be needed. When properly designed the latter reduces the labour of haulage by horses very considerably.

Now the speeds attained by horses with heavy loads are, comparatively speaking, very low, a cart carrying 3 tons seldom reaching more than 2½ miles an hour, a state of things which increases very considerably the cost per week to an electricity undertaking for vehicles on the mains. That these figures for speed can be easily surpassed by a motor vehicle, goes almost without saying, while it can be readily understood that the additional speed will reduce the number of vehicles required to a minimum. Not only would this result be attained, but a marked reduction in the cost would be noticeable, as an examination of the following table will show. The data for the steam wagons are based upon the haulage of heavy goods, not necessarily for use on cable laying, though the weights and speeds serve to illustrate the superiority of the machine over the horse.

Horses.	Motors (Steam).*
One horse with 3 tons travels 2½ miles per hour. Keep of one horse per week, 11s.; driver, 22s. Repairs, about 2s. 6d. per week per cart. Cost of each horse and cart complete, £70; total cost for 12 complete sets, £840.	One 7-ton lurry = 12 horses; speed per hour, 5 miles minimum, 7 miles maximum; uses 15 lbs. of coke per mile; driver, 28s. per week. Repairs, about £50 per annum; initial cost, about £670. Makers consider one steam lurry capable of doing work equal to the expenditure of £24 per week on horse-drawn vehicles.

* Data supplied by Messrs. Simpson & Bibby, Cornbrook, Manchester. Particulars based on actual experience of steam lurries.

It must not of course be expected that the adoption of motor vehicles for haulage on mains would do away with all troubles, as such an expectation would be unreasonable, to say the least. Motor wagons have not yet attained perfection, though the present types only need a trial in order to illustrate their capabilities, and call forth improvements as occasion demands their introduction. The steam motor certainly carries the palm for simplicity, and it possesses an undoubted advantage when used on electricity works, that in case of breakdown, it can be handed over to the fitting staff at the station, who will be familiar with the principles underlying its construction, and able to carry out the repairs needed. Again, there need be no difficulty in training the majority of horse drivers to manipulate the wagon, although they could not be expected to undertake any repair work. By the adoption of such a course the standard of driver would considerably improve, as greater attention would be demanded of the man in controlling his vehicle, and a consequent sharpening up of his faculties would result. Not only this, but the presence of a vehicle propelled by machinery would instil into the driver the necessity of becoming more closely acquainted with the working parts, a circumstance which would probably result in his ultimately being able to take entire charge of the wagon, and undertake small repairs. The standard of workman would thus be raised by promoting a keen interest in the work done. This is sorely needed nowadays, when it is becoming more and more the custom to make men into machines, by giving them control over some detail in a large system, whereby their views are narrowed, and their hopes of progress or enlightenment small.

There is another aspect in which the application of motor vehicles to mains work can be viewed. When several miles of extension are in hand, it is necessary to employ gangs of from 30 to 50 men. The extensions in question will be located, perhaps three or four miles from the generating station, at which place the time office will be situated. Now it is the usual practice for the men to walk out to the trench where work is in progress, and book on at the cabin, which is temporarily employed as a time office. The checks are subsequently taken up to the works by one of the men who will be generally told off the job. In cases where the men cannot take a tram (at workmen's rates) they will have to walk a considerable distance, and should they be late will perhaps get quartered when they arrive at the cabin. At the close of the day's work, the men will have to tramp the same distance home again after toiling for 10 hours in the trench; even though walking money is allowed, the effect on the men will be the same, and in many cases they will not turn out every morning to be at the cabin at 6. They find that there is too much work attached to the job, and naturally they cannot stand the continual strain. Now if motor vans were employed, the men might book on at the works at 6 prompt, and be taken down on, say, a couple of wagons to the trench, while in the evening they might be returned to the works by a similar means.

Such a course would possess at least three distinct advantages; the men would turn up more promptly every day to their work and feel more fit on arriving than if they had to rise two hours earlier and walk; the time-keeping would be confined to the chief office at the station and no delay in the daily returns would be occasioned; the men would work more heartily in that they would realize that their interests were considered with a view to affording them greater facilities for reaching the trench. There would be no difficulty in arranging matters so that the wagons could take the men to and fro, and the small cost would be well saved by the additional work which would be forthcoming from the men. During the rest of the day the wagons, of course, would be employed for the haulage of material, &c.

The above remarks deal with the employment of motor wagons by Corporations, but in conclusion a word must be said to contractors who hire out horses and carts. It is essential that these contractors should realise at the earliest opportunity that the motor wagon is now a serious competitor with the horse-drawn vehicle, and where it has been the custom for a man to hire such vehicles to Corporations, say, for work on the mains, it is to his interest that he be not left behind in the race for first position.

He must fully understand that the conditions of the present day demand that work should be carried out as economically and expeditiously as possible, and as long as he sticks to inadequate methods of haulage, he must expect to be left behind. He can ill afford to bear the loss which serious competition with motor vehicles would occasion him, so that he must look to it that he adopts up-to-date methods. The purchase of one or two vehicles would enable him, by the additional custom he would obtain, to dispense with the remainder of his horses, and finally carry on his business with the motor-driven vehicles.

CORRESPONDENCE.

Examination Test for Electrical Engineers.

It is, I am assured, a matter of deep regret to many who have the true interests of our profession at heart, that up to the present no decisive steps have been taken towards the

inauguration of a qualifying examination for electrical engineers. Before the admission of neophytes into their ranks, all other professions insist that certain courses of study and preparation shall be gone through, and certain tests in the form of oral and written examinations applied. Surely the time is near when this will be so with the profession of electrical engineering. What an unsatisfactory state of affairs would exist if the learned and experienced physician were compelled to enter into competition with the loud-voiced quack, or the trained veterinary surgeon with some ignorant, self-assertive groom or stable lout. The reforming hand of Time has made such a state of affairs an impossibility in our day, and the holder of the medical or veterinary diploma is a man whose claim to be regarded as a possessor of technical qualifications is indisputable.

Is it so, may I ask, in the profession of electrical engineering? Is the early training of our engineers the best that can be given to them? Let us look calmly and dispassionately about us, and see what is the order of things.

The young men who enter our central stations at the present day may be considered, almost without exception, as men whose principal objects are the attaining to lucrative posts under corporations. If in the attainment of these ends these men did their utmost by going through a thorough course of study, and acquiring a proper and useful experience, everything would be very commendable. Unfortunately, the embryo engineer soon learns that this is not altogether necessary to his success. A couple of years manipulating the switches and writing the logs of the switchboard are sufficient for his purpose. He is then an engineer, and begins to look about him for some means of bettering his condition, confident that interest and a beneficent chief—to whom he has paid a fee—will do the trick. When such a man comes to the management of a small station, he lays himself largely in the hands of his contractors, who will see him through so long as it is to their interest to do so. A capable assistant, disguised as a draughtsman, is not to be despised.

It must be admitted that many imperfectly qualified men secure good appointments nowadays. It is so easy to impress the everyday grocer, baker, &c., who sit upon electricity committees. The glowing testimonials—perhaps the personal influence of an interested engineer—doubly interested in many cases in trying to rid himself of an incubus, rarely fail in doing the good work.

It will be evident to anyone who carefully considers the matter, that interest and assurance are, in many cases, of greater moment than technical qualifications. The writer, whose experience dates from the days when so little was known about the design of the common, or garden, dynamo, that its armature core was insulated from the spindle, has had many opportunities of watching the progress of events. Those early days referred to were remarkable for the production of many strange species of electrician. Have we not seen the blatant carpenter and his ignorant labourer blossom forth into electrical engineers, and with a loud voice command the attention of an admiring public? Are we not assured that at least the shadow of their mantles has fallen upon their latter day disciples? Would it be credited that not less than a year ago, the writer of this letter, at the time acting as electrician for an asylum in the south of England, was solemnly assured by the ornamental chief in charge, that the proper way to keep the pressure equal on the three-wire system was to "boost the middle wire!" Alas! the writer could afford many instances of this kind, were it within the province of the present letter to do so.

It may be urged that it would be difficult to put up the barrier of a qualifying examination. The writer, however, fails to see how that would prove so. If some of our eminent engineers were approached, the matter would be easy enough. It might indeed pave the way towards a charter of incorporation. Its greatest opponents will be the men who have everything to lose and nothing to gain by it. They at least may be depended upon to put every obstacle in the way. They will doubtless urge that the man who could pass an examination might be an indifferent engineer, and that it would be easy to "grind" up for it. The practical work required at an oral examination would effectually stop such a man, is the writer's answer. It would be difficult to make it compulsory? Not a bit. It would become in the wholesome competition it would bring about—a necessity. Perhaps other readers have their opinions. If so, they would be gladly read by

The Booster of the Middle Wire.

Manningham,
July 27th, 1901.

Continuous Current Dynamos.

I am glad to see Mr. Mavor's letter in the current issue of the Review. Respecting the value of r in his formula No. 3, suppose we apply the formula to a machine, the particulars of which have been published, say the 200-kw. generator on page 190 of Messrs. Parshall & Hobart's book.

Taking Mr. Mavor's formula first, $\frac{G}{b} = 146$, $n = 2{\cdot}25$, $f = 7{\cdot}9$, $l = 36$, $b = 3$, $c = 400$, $p = 6$, and $m^2 = 4$,

$$r = \frac{2 \times 3{\cdot}14 \times 146 \times 2{\cdot}25 \times 7{\cdot}9 \times 36 \times 3 \times 4 \times 400}{6 \times 10^8} = 4{\cdot}7.$$

Taking my formula, $D = 39''$, $R = 135$, $f = 20$, $l = 14{\cdot}25$, $c = 66{\cdot}6$, $m_1 = 12$, $m_2 = 2$, and $t = 0{\cdot}5''$,

$$r = \frac{{\cdot}1645 \times 39 \times 135 \times 20 \times 14{\cdot}25 \times 66{\cdot}6 \times 12 \times 2}{{\cdot}5 \times 10^8} = 7{\cdot}89.$$

which practically agrees with Messrs. Parshall & Hobart's figure of 7·85.

It may be that I have misread Mr. Mavor's symbols, and if so, this would account for the discrepancy between us, which, until his letter appeared, I thought to be due to a misprint.

I do not think the general statement that the E.M.F. of self-induction varies as the square of the number of turns per section, is a good way of putting it. Suppose we halve the number of commutator bars, and so obtain double the number of turns per section. The bars being wider, the brush will not short-circuit so many coils; if, for instance, it short-circuited three coils before, it may only short-circuit two now, so that the magnetising turns will not be doubled, but will be increased in the proportion $\frac{8}{6}$, the time of commutation will be unaltered, so that the reactance voltage will be increased in the proportion $\frac{8}{6} \times 2$.

If, however, we widen the brush so as to short-circuit the same number of coils as before, then the magnetising turns will be doubled as well as the turns per section, but still the reactance voltage will not be increased in the proportion of the square of the number of turns per section, because the brush having been widened, the speed at which commutation takes place is lowered.

As regards the respective merits of $\frac{e}{r}$ and $\frac{A - A_1}{A_2}$, I still prefer the latter, partly because my records are made out in that form, and I should not care for the trouble of recalculating them, and partly because I think the values in Col. 4 a better guide to the designer. For instance, the machine No. 3 is a possible machine, while No. 4 is so bad as to be quite impossible. A designer having the results of No. 3 before him, would be frightened by the drop from 3·5 to 1·48, and would re-design, but the drop from 1·72 to 1·63 does not look so serious, and he might be inclined to risk it, and let the design go through. However, the one method is as good as the other, if one has the records to go on. The absolute value of r, as given in the above formulæ (whether mine or Mr. Mavor's), rests upon an incorrect assumption, namely, that the only lines cut by the commutating coils are those due to the current in themselves, no account being taken of the lines due to the current in the adjacent coils of the armature winding.

When we have to work with fixed brushes, it appears to me that what we want to aim at is to produce, under the extreme conditions of load to which the machine may be subjected, a *resultant* voltage in the short-circuited coils insufficient to cause sparking.

I am glad to note that Mr. Mavor corroborates my views as to cost of machines.

Claude W. Hill.

London, *October 14th*, 1901.

The Purchase of Foreign Machinery.

Attention has several times been drawn in your columns to the strong feelings which a certain section of our own body of engineers hold in favour of foreign made machinery. In some cases these feelings are prompted by necessity, and such engineers are forced to go abroad for their requirements; in other cases it is merely a matter of preference though the same arguments are put forward.

The correspondence which found its way into the technical and daily press, on the subject of the Manchester Switchboard Contract, is no doubt an instance of the former. Numerous orders for electrical machinery, however, leave the country, which cannot be included under that class, and if they could the home manufacturer would have no cause to complain.

He has, however, good reason to feel ill-treated when preference is distinctly shown to foreign firms. I refer to cases such as the order recently given out by the Corporation of Manchester for arc lamps for their Bloom Street station, in which it was distinctly specified that no other but a definite foreign lamp would be considered.

It is pretty well known by those conversant with the arc lamp industry that no lamp has yet been made in America or on the Continent which can compare satisfactorily with the arc lamps made by some few of our home manufacturers, taking everything, including price and delivery, into account; and yet for a small order of 60 lamps, it is considered necessary to specify a foreign made lamp.

This is only one of the many cases which are daily occurring which prove conclusively that a certain section of our body of engineers are either hostile to home manufacturers, or are unacquainted with what is being produced in this country.

I draw attention to this particular case, which is only one of many arising almost daily, because it is not consistent with the remarks recently made by the Chairman of the Manchester Corporation Electricity Committee, on the occasion of the placing of the switchboard contract, when he expressed regret at having to purchase abroad. On that occasion such remarks were quoted wholesale to show that our public bodies wished to place their contracts at home, but were compelled to go abroad.

I do not doubt that as things turned out with regard to the switchboard contract they were compelled to go abroad, and but for many similar actions, such as the specifying of the lamps referred to above, to which attention is not usually drawn in public, I should be quite willing to believe their patriotic remarks and lay the blame against the manufacturers of this country.

There are some who believe that our manufacturers alone are to blame; they would not always believe this if they saw the manufacturers' side of the business.

British Manufacturer.

Coal Consumption per Unit in Traction Stations.

It is now four weeks since I asked "W. H. J." to kindly give some further information respecting the plant from which such wonderful results are obtained.

Surely, *now that the interesting discussion is opened*, he is not going to leave us in ignorance of how it can be done (if it ever has been done)?

Or, if "W. H. J." has discovered an error in his readings or calculations, I think he might at least say so.

W. R.

Fulham, *October* 14*th*, 1901.

Consulting Engineers as Arbitrators.

I have been much interested in a paragraph which appeared on page 513 of your issue of September 27th, respecting the treatment of a contractor by the engineer of the Town Council of Rothesay.

This case, which is one of enormous interest to all contractors, illustrates once more the fact that consulting engineers in Scotland exercise their functions in an independent and judicial spirit.

I have myself had experience in a similar case in Scotland, where the engineer of the authority supported fair treatment to the contractor, and, in fact, insisted upon fair treatment being given to him. This Rothesay case, however, shows what an exceedingly strong man it requires to take up such a position, because it is an almost invariable rule for members of a local authority to regard their engineer in very much the same light as the keeper of a public house regards his "chucker out." He has to be a strong man, but his strength is to be used entirely at their good will and pleasure.

If consulting engineers generally would recognise that when they are appointed sole arbitrator between the buyer and seller they are expected to treat both sides with justice, there would not be the present absolute necessity on the part of contractors to refuse such arbitration whenever it is proposed.

Contractor.

October 14*th*, 1901.

Johnson-Lundell Electric Traction Company.

In your issue of September 27th last, there appear on page 524 under "City Notes," a few comments on this company's directors' report, and in referring to the capital you say: "As, however, only £15,000 of the capital remains in hand, &c., &c." £15,000 odd was certainly all the available cash at bank and in hand on April 30th last, but there is still an amount of £2 per share liable to be called up in respect of 34,796 shares, part of the 39,796 partly paid shares, which provides a further sum of £69,592 for working capital.

The Johnson-Lundell Electric Traction Co., Ltd.
A. Tilley, *Secretary.*

London, W.,
October 14*th*, 1901.

Electric Welding.

With reference to your notice in last week's issue of an electric welding plant being installed by Messrs. Crowther and Co. for Messrs. Richard Johnson & Nephew, Bradford Ironworks, Manchester, we should feel obliged if you would allow us to state that the plant has been supplied by us, and consists of our patent Thomson automatic electric wire welders, of similar type to those used by the following well-known firms in this country:—Messrs. W. N. Brunton and Son; Messrs. Callender's Cable and Construction Company, Limited; Messrs. Dorman, Long & Co., Limited (on order); the Eastern Extension Telegraph Company; Messrs. W. T. Glover & Co., Limited; Messrs. Siemens Bros. & Co., Limited; the Telegraph Construction and Maintenance Company, Limited; the Whitecross Company, Limited; &c., &c.

The Electric Welding Company, Limited.

Electricity v. Other Illuminants.

I write to ask if you or any of your correspondents have recently tackled the above vexed question.

Now that so many comparatively new illuminants are being introduced into the market, such as the Kern gas burner and the Kitson light, I venture to think that some list giving accurate information as to the cost of the various methods in comparison with electric light would be a most valuable paper.

To the ordinary contractor without the necessary apparatus such a list would be rather a difficult thing to obtain, but if any of your correspondents have recently gone into the matter the result must be a great boon to the electrical world generally and to me in particular.

Luminosity.

LEGAL.

The Finchley Electric Light Company, Limited, *v.* The Finchley Urban District Council.

In the Vacation Court on Wednesday, before the Lord Chief Justice, Mr. Buckmaster moved, on behalf of the plaintiffs in this action, for an interim injunction to restrain the defendants from taking down or otherwise interfering with overhead electric wires.

E

Learned counsel stated that the plaintiff company were not incorporated by virtue of any Acts of Parliament except by that of the Act of 1862, and consequently they possessed no powers and derived no protection from any of the Electric Lighting Acts, and they had none of the privileges conferred by those Acts. They were not in a position to break up the roads without the consent of the local authority, and being prevented from laying their cables underneath the roadway, they proceeded to carry their wires overhead at a height of 34 ft. They had been served with notice of regulations from the Board of Trade, and it was their case that those regulations had been complied with. The defendant Council had cut one of their wires, and had thus prevented the company from carrying out contracts which they had made for the purpose of supplying electricity to customers in the district. It was a matter of the greatest possible importance that those contracts should not be interfered with, but one wire had been cut on October 1st, and had now been down 14 days. Unless the defendants could satisfy his Lordship that they had some right to cut the wire, he submitted that the plaintiffs were entitled to an injunction. According to the Wandsworth case, the local authority had no power to interfere with wires when they were carried overhead at a height of 34 ft. above the roadway. The defendant Council had attempted by all means in their power, legitimately and illegitimately, to interfere with plaintiffs' enterprise. They had refused to allow the wires to go under the roadway, and now they were trying, by means which were not legal, to interfere with the company carrying them across the road.

Mr. Chubb, for the defendants, submitted that the motion was a most improper one to bring on in the long vacation.

The Lord Chief Justice: Are you willing to give an undertaking?

Mr. Chubb: I will not interfere with any wires now standing until such day as your Lordship thinks proper.

The Lord Chief Justice: Are you willing that the plaintiffs should put up the wire you have cut down?

Mr. Chubb: I cannot agree to that, as it would put plaintiffs in a very different position from that which they now occupy.

The Lord Chief Justice: I did not ask you anything about position. Why should you cut down any new wire they may put up? Suppose they obtain the consent of householders on each side of the road, what power have you to prevent them putting up a wire?

Mr. Chubb: They don't suggest that they have that consent.

The Lord Chief Justice: Suppose between now and the hearing of the motion they put up a new wire and then proceed to supply electricity through it, what power have you to prevent it?

Mr. Chubb: I ask your Lordship to maintain the *status quo* until the hearing of the motion.

The Lord Chief Justice: But you are not maintaining the *status quo*. You have cut down one of their wires and ask that they should be prevented from restoring it. Why should you not be restrained from cutting it again?

Mr. Chubb: If they were allowed to put up the wire it would be the commencement of a new business, and we have the right to prevent their erecting their wires, as the protectors of the rights of the public over the streets.

The Lord Chief Justice: Will you show me any authority, statutory or otherwise, giving you the right to cut down the wire?

Mr. Chubb: By Section 14 of the Electric Lighting Acts of 1882, no wires can be carried under or over a street without the express consent of the local authority. The plaintiffs have not obtained that consent, and consequently we have the right to remove the wires.

The Lord Chief Justice: Supposing that a man having a factory on either side of the road, and having an electric lighting apparatus on the north side, should desire to carry a wire across to the south side for the purpose of lighting the premises there, could you cut it down?

Mr. Chubb: I should submit so, unless he had obtained our consent.

The Lord Chief Justice asked Mr. Buckmaster who would be willing to give an undertaking in damages in the event of his granting an injunction.

Mr. Buckmaster said that the managing director of the company would give his personal undertaking.

The Lord Chief Justice, without calling upon Mr. Buckmaster to reply, said that on the facts before him he must assume that, somehow or other, the plaintiffs had obtained the consent of property owners to have their wires affixed to opposite premises. They had put up their wires at a height of 34 ft., and the defendants had cut one of these down. They stated their willingness not to cut any more down, but they sought not to maintain the *status quo*, but to maintain the result of their own act, which might be a wrongful act. He thought the plaintiffs were entitled to an injunction in the terms of the notice of motion until the trial, the costs to be costs in the action. He would give liberty to apply in the event of there being any ground for the Court relaxing the injunction.

German Electrical Industry.—The *Financial News* states that a very bad report has been issued by the Helios Electrical Works Company at Cologne and its trust company. The Helios Company has lost, in round figures, one-quarter, and the trust company one-third part of its capital. But this heavy loss has already been discounted by the market, for the quotation of the Helios is only 34 per cent., and of the Trust 26 per cent. The Schuckert Electricity shares lost 10 per cent. on unfavourable reports on its Scandinavian enterprise.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Oct. 16th, 1900.		Week ending Oct. 15th, 1901.	
Amsterdam	Value £144	Amsterdam	Value £90
Auckland	178	Auckland	80
Bombay	274	,, Teleph. mat. ..	195
Buenos Ayres. Teleg. mat. ..	226	Bombay	141
Calcutta	3,736	,, Telephones	214
Cape Town	292	Buenos Ayres	83
Colombo	16	,, Teleph. cable ..	945
Copenhagen. Teleg. wire ..	44	Calcutta	1,139
Durban	2,200	Cape Town	39
,, Teleg. apparatus ..	1,014	Christiania. Teleg. wire ..	33
East London	61	Durban	3,612
Gibraltar	243	,, Elec. tramway mach'y	4,153
Halifax. Teleg. mat.	29	East London	80
Hamburg. Teleg. mat... ..	200	,, Teleg. sundries..	72
Hokitika	11	Gothenburg. Teleg. cable ..	1,521
Hong Kong	141	Grenada. Teleph mat.	60
,, Old teleg. wire ..	88	Hamburg	24
,, Submarine cable ..	330	Hong Kong..	1,203
Launceston	138	Kobe. Teleg. cable	6 534
Malta. Teleg. apparatus ..	302	Madras	1,983
Melbourne	129	Melbourne	110
,, Teleg. mat. ..	2,349	Port Chalmers. Teleph. mat.	71
Newchang	11	Rosario	85
Ostend	757	Rotterdam. Teleg. wire ..	48
Otago..	894	Shanghai	168
Perth..	84	,, Submarine teleg. cable	7,319
Port Elizabeth	37	Sierra Leone. Teleg. cable ..	20,040
,, Teleg. mat. ..	366	Singapore	80
Port Said	20	,, Submarine teleg. cable	48,000
Shanghai	16	Stockholm. Teleg. cable ..	476
Singapore	60	Sydney	1,033
,, Teleg. mat.	30	Wellington	626
Stockholm. Teleg. mat. ..	260	,, Teleg. mat. ..	
Sydney	1,111		
,, Teleg. mat	754		
,, Teleph. mat.	1,140		
Wellington	454		
Yokohama	2,341		
,, Teleg. mat. ..	4,5·6		
Total ..	£24,576	Total ..	£100,815

Foreign Goods Transhipped.

Flushing. Elec. apparatus ..	£52
Hamburg. Elec. detonators ..	450
Sydney. Teleph. apparatus ..	855
Total ..	£1,357

Bankruptcy Proceedings.—The public examination of Thomas Morley, an electrical engineer, of Accrington, took place at the Blackburn Bankruptcy Court on 8th inst. The proceedings were adjourned. The gross liabilities were stated at £275, and the deficiency as £217.

At the Newcastle Bankruptcy Court last week, J. A. M. Collier, mechanical and electrical engineer, Gateshead, was publicly examined. His unsecured liabilities, it appeared, amounted to about £140. He attributed his insolvency to his having to spend money freely in order to bring business to the Gateshead Mechanical and Electrical Supply Company, of which he was managing director. The examination was adjourned until October 31st.

Under the failure of Wm. R. Beckton, electrical and general engineer, 13, Brownlow Street, Holborn, an application was made to Mr. Registrar Linklater last Tuesday at the London Bankruptcy Court to approve a scheme of arrangement providing for the payment of a composition of 7s. 6d. to the unsecured creditors. Mr. E. S. Grey, Assistant Receiver, reported that the debtor failed last August with ranking liabilities £997 1s. 6d. and assets estimated to produce £425, after deducting £62 8s. 4d. in respect of the preferential claims. The sum of £535 would be required under the scheme, which accordingly would benefit the general body of creditors. The debtor was in employment as an electrical engineer prior to September, 1898, but then, with about £860 capital, commenced and had since carried on the business of an electrical engineer at 13, Brownlow Street. He attributed his failure mainly to loss in trading consequent upon heavy trading expenses, to bad debts (£154), law costs (about £105), to the cost (about £490) of alterations and repairs, which he agreed to execute on obtaining a lease of his business premises, and to depreciation (estimated at £100) in the value of his stock and plant as estimated for realisation. His household and personal expenses during the three years' trading had amounted to about £600. The offences reported by the Official Receiver were (1) insufficiency of assets to pay 10s. in the £ to the unsecured creditors, and (2) imperfect book-keeping. After reading the report, his Honour held that the proposal was reasonable, and calculated to benefit the general body of creditors. The scheme was accordingly approved by the Court.

Dissolutions and Liquidations. — Creditors of the Electrical Transmission Company, Limited, are to send particulars of debts, &c., to the liquidator, Mr. A. R. Clarke, 7, East India Avenue, E.C., by November 30th.

Messrs. G. E. Norvall and S. Parkinson (electrical and general engineers, Essex Road, Islington, City Engineering Works) have dissolved partnership. Mr. Parkinson is to attend to debts.

Messrs. F. & A. H. Hodgson, and F. G. Andrews (F. Hodgson and Co., electrical engineers, builders, &c., Downshire Hill, Hampstead) have dissolved partnership.

Book Received. — "*Mechanical World* Pocket Diary and Year Book for 1902." Manchester: Emmott & Co., Limited, *Mechanical World* Offices. 6d. net.

Catalogues.—The B.T.H. Co. has issued a new list of its punched clip switches.

Messrs. Gent & Co., of Leicester, have sent us a copy of their new catalogue of electric bells, indicators, &c. Their name is well known to the trade as being manufacturers of English-made materials. All materials detailed in the list are made up at Leicester, those turned out at the Berlin factory being dealt with separately in another list. There are numerous illustrations, also price details. An accompanying book (Part I.) of 28 pp. shows how to fix and repair electric bells, &c. It is got up in style suitable for workmen's use. Since their last issue the instructions have been amplified and brought up to date. Part II. is now in course of preparation.

From M. Ickelheimer, of 36A, Aldersgate Street, E.C., who is the London agent for M. Fleischmann, of Vienna, we have received a price list of carbon plates, cylinders, &c., for battery and other purposes.

Messrs. E. F. Moy, Limited, are circulating a list of their dividing boxes for joining two single cables to the end of a concentric main.

Messrs. Atkinson, Schmahl & Co., of Newcastle-on-Tyne, we have received a new trade price list of the dynamo brushes supplied by Mr. P. Ringsdorff, of Essen, for whom they act as sole selling agents. Brass, copper, gauze and carbon block brushes are detailed.

Messrs. Francis & Spilsbury, of 20, Bucklersbury, E.C., have sent us an illustrated catalogue of the cranes, hoisting machinery, lifts, &c., supplied by Messrs. Mohr & Federhaff, of Mannheim, for whom they act as agents in this country. A number of photographs of electric wharf cranes, overhead travellers, fixed electric cranes, also a large variety of steam cranes are given. Several pictures show their travellers in service in Continental electrical stations and factories.

Messrs. C. Redman & Sons, of Pioneer Ironworks, Halifax, who recently largely extended their factories for the manufacture of machine tools, have sent us some circulars with beautifully executed illustrations, showing their specialities. Several lathes (8½ in., 10½ in., and 12½ in. centres) of new design, following out the most improved practice, and being very strong and powerfully geared, are described in separate lists. Improved planing and shaping machines are also included.

A new list issued by the James Keith & Blackman Company, Limited, describes their latest developments in heating, mechanical ventilation, and drying, as illustrated at their excellent Glasgow Exhibition stand.

A catalogue of Mr. F. J. Borland's scissors arc lamps, cinematograph lamps, resistance frames, choking coils, stage projectors, gallery lamps, automatic fuse replacers, Universal enclosed arc lamps, and other specialities, has been sent to us.

From Messrs. Estler Bros., of Laurence Pountney Lane, E.C., we have received a copy of their trolley catalogue, No. 1, 1901. It comprises illustrated descriptions of a number of trolley standards, poles, heads, wheels, &c., manufactured by Messrs. Lowdon Bros. and Co., of Dundee, for whom they are sole English representatives. Another list describes Messrs. Estler's gas-blast muffle furnaces for tempering, annealing, and enamelling. Instructions for erecting and working the gas blast furnace are given.

Messrs. J. Halden & Co., of Manchester and other places, have sent us a list with description of the Shaw & Halden's patent arc lamp Duplex radial copying frame for printing from two tracings at one operation.

We have received a list of technical and other books published by Ch. Béranger, Librairie Polytechnique, of Paris.

Fletcher v. London United Electric Tramways, Limited.—In the Brentford County Court on Friday last Judge Bagshawe, K.C., gave his award in the above arbitration, in which Wm. Fletcher, a labourer, claimed damages on account of injuries sustained while employed by the company in April last in laying down their lines in the Uxbridge Road, near Ealing. A splinter flew off a steel pin which was being driven into the ground, struck applicant on the nose and severed an artery. The decision hinged wholly on the point as to whether the work was engineering work, and whether the tramway was a "railway" within the meaning of the Act. Mr. Compton, the counsel for the applicant, contended that the tramway was as much a railway as the now familiar "Tube," which was actually called the "Central London Railway." What did it matter whether the same carriages were propelled by the same power underground or along the street? His Honour, however, thought that the real difference lay in the permanent way, which in the case of railways was used solely by the railway carriages, but in the case of tramways was used also by all the ordinary traffic. The learned Judge dismissed the application. There was no order as to costs.

Imports of Foreign Electrical Plants.—The value of the foreign electrical goods and apparatus imported into this country during September last is returned at £46,651, which compares with the £42,096 in the preceding month and £97,107 in the corresponding month of 1900. So far as the year has gone, there has been a decline in these imports, the value for the nine months ending with September last being returned at only £683,820, as contrasted with £794,699 in the first nine months of last year.

The "Playgoer."—Vol. 1, No. 1 of this illustrated monthly magazine of the stage and all amusements is bright and entertaining. It is edited by Fred. Dangerfield, published by Dawbarn and Ward, Limited, and looks like making a good hit. Pictures of performers and their performances are a leading feature, but the chief item of the first issue is very fittingly devoted to "The Art of Ellen Terry," an article thereon with many photos being contributed by Bram Stoker.

Smoke Nuisance.—On Thursday last week, at Willesden, the Metropolitan Electric Supply Company, of 16, Stratford Place, W., were summoned by the Willesden District Council with reference to a smoke nuisance at their works at Acton Lane, Willesden. The dates set out upon which "black smoke was discharged from the chimney shaft, in such quantity as to be a nuisance, notwithstanding the notices of the Council to abate such nuisance," were one day in June, three in July, and five in September. Mr. Bartley-Dennis was counsel for the District Council and Mr. Barlow for the company. Mr. Bartley-Dennis said Mr. Barlow assured him that the notices to abate the nuisance had not gone further than the works, and the first the company knew of the matter was when the summons was served last Monday. The notices were served on the engineer at the works. The nuisance was admitted and amendment promised, and, with the consent of the Bench, an agreed penalty of £2 and 12 guineas costs had been arranged. Mr. Lockett imposed the penalty agreed upon, and Mr. Barlow said the company would do their utmost to prevent any nuisance.

Trade Announcements.—Mr. A. C. Cossor notifies that on October 19th he is moving to larger premises at 54, Farringdon Road, E.C., the removal being occasioned by increasing business.

All communications for the Brunswick Electric Lamp Company should in future be addressed to Brunswick Works, Brunswick Place, City Road, N.

We understand that Mr. F. S. Dudgeon, of 30, Great St. Helens, now represents the Phœnix Dynamo Manufacturing Company for London and District.

The New Brotherton Tube Company, of Wolverhampton, notify that they have opened offices and stores at 9A, New Brown Street, Manchester, for the distribution of their enamelled steel conduit tubes and fittings. All communications for that district should be sent to that address.

Messrs. A. Reyrolle & Co., Limited, announce that constantly increasing business has compelled them to extend their manufacturing capacity, and necessitated the transfer of their head office to Hebburn-on-Tyne, where they have erected large works. By means of the latest English and American machinery they hope to be able to turn out orders in much less time than hitherto. The company have, in addition, erected special stoves for the enamelling of slates, and are prepared to supply contractors with enamelled slate slabs and marbles drilled ready for mounting. The speciality of the firm is the manufacture of large distribution switchboards, many of which are already in use in different English towns.

The London depôt for the supply of electric light cables, &c., manufactured by Messrs. Isidor Frankenburg, Limited, has been removed to 26, Shaftesbury Avenue, W., where their agents, the Accessories Manufacturing Company, will keep a large stock.

What the British Consuls Have to Say.—*Telegraphs and Telephones in Algeria.*—The establishment of a second telegraph wire, connecting Algiers and Laghouat, was decided upon a short time ago with a view of accelerating telegraphic communication with the extreme south of Algeria; this line was pushed on with the greatest vigour, and was finished recently, being now in regular working order. According to the report of Consul-General Hay-Newton, this great telegraphic artery, penetrating the south of Algeria, will be doubled, if necessary, later on, as far as Ghardaia. The total length of telegraph line in Algeria is now 6,494½ miles, of which 6,487 is above ground and 7½ miles below ground, being an increase of 486½ miles in the length of line existing at the end of the year 1899. On account of the high charges for installation, &c., of telephones, Consul-General Hay-Newton states, Algeria is much behind other countries in this respect.

Government Telephones in Sarawak.—Consul Hewett, reporting on the trade and commerce of Sarawak (Borneo) for the year 1900, states that the Government has not yet constructed any telegraph lines, but has a very complete telephone service in Kuching, connecting all the Government offices, and also used by the Chinese merchants commercially. This service is extended in Upper Sarawak district as far as the Borneo Company, Limited, works, at Bau, Busan, and Bidi, a distance of about 26 miles.

German Electrical Trade in Russia.—In a report on the trade of the consular district of Odessa, received at the Foreign Office on September 9th, Consul H. P. Smith (Kieff) states that in electrical machinery Germany has the monopoly of the Russian market, and, in his opinion, there is no doubt that her manufactures are worthy of the immense trade she now does in that branch. All the principal German firms, he states, have their own offices in the city of Kieff, with a complete staff of electrical engineers. He considers that it is not at all satisfactory that the United Kingdom cannot hold its own in supplying the Russian market with electrical, agricultural, and general machinery, but is now outstripped by Germany, which supplies about 50 per cent. more of Russia's industrial trade than the United Kingdom. In some cases certain machinery is advertised as being more powerful and better constructed than that made in the United Kingdom, but, Consul Smith states, the British manufacturer has the satisfaction of knowing that his machinery has been used as a pattern and copied in almost every detail.

Germany.—Consul-General Francis Oppenheimer, in a recent report on the trade of the consular district of Frankfort-on-Main states that, according to statistics published by the *Electrotechnic Journal*, there existed on September 1st, 1900, electrical railways in 99 German cities and districts, as against 3 in 1891, 32 in 1895, and 88 in 1899. The progress of the past year, he points out, however, is not so

much characterised by the considerable addition of cities as rather by the very considerable extension of the electrical workings in some of the towns. The above-mentioned electric tramways in 1900 had a total length of 2,868 kiloms.; in 1899, 2,048 kiloms.

Telephone Service in Germany.—The working of the telephone in Germany, Consul-General Oppenheimer states, seems to be more satisfactory, and is growing in favour with the public for long distances, the exchange of telephone messages between inhabitants of different towns being nearly twice as numerous as that of telegrams. In future telephone automatic machines are expected to further facilitate telephonic intercourse. A charge of 10 pf. (1½d.) is made for a local conversation of three minutes, 20 pf. for a connection with the suburbs. Conversations over longer distances from one town to another are not provided for. The favour which these apparatus enjoy with the public, it is thought, would be further enhanced if provision were made for greater privacy by placing the automatic machines in cabins. Between Berlin and Cologne an innovation has been started, viz., that of a reduced subscription for conversations which take place between the same parties regularly at the same hour during night time. Such conversations are limited to between six and twelve minutes, and the price charged is half the day charges for equally long conversations.

Train Lighting in Germany.—Two very serious accidents which occurred to express trains in the vicinity of Frankfort last year were rendered particularly disastrous by the gas carried with the train—a mixed gas of oil and acetylene—exploding and the cars catching fire, escape being very difficult on account of the windows being protected by cross-bars, and the fact that the corridor cars possessed only one door at each end of the car. To prevent similar occurrences the general introduction of electric lighting in the railway traffic was proposed, but so far the suggestion has only been adopted in single instances, mainly with the post office railway carriages. The proposition, Consul-General Oppenheimer states, was opposed by the railway authorities, who argued that the introduction of electric lighting would increase the risk to the travelling public, and that so far explosions of oil gas had only occurred twice in the history of the German railway service. A conference was held at the end of last year, which examined very carefully the question of new designs for cars which are to run on express trains, and it was decided to build a new train, including dining and sleeping cars, and to exhibit it for public inspection.

Electric Traction in Bahia (Brazil).—The city of Bahia is divided into a lower and an upper town. Communication with the lower town, Consul Medhurst reports, is achieved by means of a well-managed electrical tramway, which runs a 10-minute service of cars to Itapagipe—4½ miles from the centre of the city—the line being owned and worked by Germans. In order to reach the upper city, which lies 200 ft. above the sea level, a hydraulic lift or one of two cable elevators has to be used.

Electric Light and Tramways in Braila (Roumania).—A concession for lighting the town of Braila with electric light was granted to a German company—"Helios"—last March, and Vice-Consul Norcop states, in a recent report, that the works will be finished in the spring of 1902. Electric tramways, however, are running in all parts of the town, as well as the docks.

German Electrical Industry.—Consul-General Schwabach, reporting on the trade of Germany, estimates that a capital of about 700,000,000 marks—£35,000,000—is interested in electrical plant works, the increased export trade of the country largely consisting of the export of electrical appliances. Exact statistical details are wanting as to the number of these appliances, but, it is stated, the Bundesrath has decided upon a more thorough and special classification of these articles in the list of statistics. Consul-General Schwabach thinks there is an enormous field of work opening before the electro-technical trade in the construction of railways in Germany, several schemes being under consideration. The plan receiving most attention at present, he states, is one for connecting Berlin and Hamburg with a quick electric railway, the cost being estimated at £7,000,000.

Workmen's Compensation.—A case of considerable interest to municipal corporations and contractors came before Judge Emden at the Tunbridge Wells County Court, on 11th inst.; for an abstract thereof we are indebted to the *Times*. The Corporation of Tunbridge Wells have been enlarging their electricity works, and the firm of Tinkers, Limited, secured the contract for putting in the boilers. One of their workmen, named Jones, while engaged in removing some scaffolding, accidentally received a shock from a "live" wire, and fell from a ladder to the ground, a distance of 30 ft. He broke his thigh and otherwise injured himself. He now brought an action for £50 against the Corporation and Tinkers, Limited, under the Workmen's Compensation Act. Counsel for the Corporation disclaimed any liability, as they were not carrying out the work themselves, and Jones was not in their employment. This case involved an important point of principle for corporations, for if they were to be held responsible for accidents to their contractors' workmen there would be no end to their liability. Tinkers, Limited, also disclaimed liability, on the ground that the work the man was engaged on was not, strictly speaking, an occupation specified in the Act; and, further, the works where the accident happened were not their engineering works or factory. Both the Corporation and the contractors therefore denied liability, but each held that the other was responsible. His Honour said it was a very remarkable case, but it was clear that neither the Corporation nor the contractors were liable according to the Act. The claim must therefore be dismissed. It was unfortunate for the workman, and he hoped something would be done for him.

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—The T.C. has authorised an application to the L.G.B. for leave to borrow £200,000, of which £80,000 is for extensions of the electricity works.

Bangor.—The T.C. has resolved to apply to the L.G.B. for leave to borrow £2,072 10s. for extensions of the electricity works. There are 180 consumers, with 6,250 lamps; the original scheme cost £15,878, to supply 4,000 lamps, but the demand has necessitated the increase of the station to supply 12,000.

Barnstaple.—An inquiry was recently held by Major C. E. Norton, R.E., L.G.B. inspector, into the application of the T.C. for leave to borrow £27,000 for electric lighting purposes.

Boston.—At a meeting of ratepayers a resolution was adopted in favour of lighting the town by electricity.

Bristol.—The Electrical Committee has decided to recommend the Council to appoint Mr. H. H. Couzens, mains engineer, to the position vacated by Mr. Phillips, who has been appointed borough electrical engineer at Bedford.

Carnoustie. — The T.C. has approved of Messrs. Crompton & Co.'s application for a prov. order to supply electricity in the burgh.

Chatham.—The Chatham Electric Lighting Company has declined the offer of the Rochester T.C. to purchase the part of the company's undertaking within the city for the sum of £5,000, and the Council has resolved to object to the proposed revocation of the prov. order relating to the Gillingham Urban District, with a view to obtaining an improvement in the service.

Coventry.—An inquiry has been held by Mr. E. A. S. Fawcett, L.G.B. inspector, into the application of the Corporation for leave to borrow £23,200 for electric lighting purposes. There was no opposition.

Dublin.—The work of the new scheme of electric lighting of this city is progressing well. The British Insulated Wire Company, who are laying the new cables, have four gangs, numbering over 200 men, engaged on the work at the different sections. Considerable progress has also been made at the Pigeon House, in connection with Messrs. Stewart's contract.

Durban.—The rapid increase in the demand for electricity for lighting and tramways has necessitated extensions of the electricity works, which are to be carried out at an estimated cost of £45,000. A sum of £30,000 is also to be expended on mains. The original outlay was £25,000.

Epsom.—The R.D.C. has issued notice of objection against the issue of a provisional order to the Leatherhead and District Electricity Company, Limited.

Falkirk.—At a meeting of the T.C. on Monday evening, it was unanimously agreed to instruct Messrs. Burstall & Monkhouse to prepare a full report on the electric lighting scheme for Falkirk, together with the subject of a refuse destructor.

Fareham.—The T.C. has resolved that an all-night supply of electricity be instituted.

Greece.—The *Levant Herald* reports that the Hellenic Electric Company, an offshoot of the Thomson-Houston Company, is building at Phalerum a central station at a cost of 4,000,000 drachmas. It will supply electricity for lighting Athens and the Piræus, and motive power for railways, tramways, and household purposes. The station will be able to produce 8,620 H.P., and will be the largest establishment of the kind in the Levant.

Grimsby.—The T.C. has adopted the report of the E.L. Committee, recommending further extensions of electricity plant at an estimated cost of £11,900.

Italy.—A project is shortly to be carried out at Lecco for the transport of electrical energy for motive power purposes and for the electric lighting of the town and district. An intake and canal are to be constructed from the River Enna, which will give a supply of water capable of developing 1,000 H.P. About 800 metres of the canal will be constructed in a subterranean gallery. The head of water will be 54 metres.

An application for the concession of a derivation of water from the course of the River Aniene was made some time ago by Mr. Alarico Piatti, of Rome. The Prefecture of Rome accorded the concession in July last, and the catchment is to be utilised for the purpose of driving turbines for the development of electrical energy, which will operate the electric railway from Mandela to Subiaco, light the town of Subiaco and the suburbs, and supply motive power for the use of different small industries in the district. The concession is for a term of 30 years. The head of water is 56·60 metres, and is capable of furnishing 3,000 H.P. The concessionnaire enters into a bond of 20,000 lire to finish the undertaking within two years of the approval of his project.

Lanteglos-by-Fowey.—The Parish Council having received no tenders for the lighting of the town, a scheme was brought forward to light it by electricity. It is said that a company will probably be formed.

Llanrwst.—The Parish Council has entered into an arrangement with the Llanrwst Electric Supply Company for electric lighting within the Council's area.

Lowestoft.—The L.G.B. has sanctioned a Corporation loan of £10,000 for electric street lighting. The T.C. has resolved to apply to the B. of T. for a license to supply electricity outside the borough.

Manchester.—At a special meeting of the City Council, held on Friday last, a contract for the erection of chimneys and other works at the Stuart Street generating station was accepted.

Monmouth.—The Corporation has fixed the charge for electrical energy for motors used in the daytime only at 3d. per unit. The estimated consumption of electricity for street lamps is 50,000 units, and the charge has been fixed at £400 per annum, equal to 1·84d. per unit.

Newcastle-under-Lyme.—The T.C. has resolved to apply to the L.G.B. for sanction to the borrowing of £8,812, the estimated cost of carrying out the electric lighting of the borough.

Otley.—The D.C. intends to apply to the B. of T. for a prov. electric lighting order.

Russia.—The three electric lighting companies in St. Petersburg have at length arrived at an agreement with reference to a uniform charge for the supply of current for electric lighting purposes. Hitherto varying prices—from 1·8 to 2·5 kopecks per hectowatt-hour—have been charged, but in future each concern will make a charge of 3½ kopecks.

Shrewsbury.—At Monday's meeting of the T.C. a letter was received from the L.G.B. sanctioning a loan of £10,900 for extending the electric lighting works and the mains.

Stockton.—The R.D.C. has agreed to apply for a prov. order to supply the district with electricity, and that the services of Mr. Vesey-Brown be obtained at a fee of 50 guineas.

Strabane (Co. Tyrone).—The Gas and Electric Committee has considered and rejected the amended estimate of the Westinghouse Company for an installation of 3,000 16-c.p. and 700 8-c.p. electric lamps at a cost of £17,716.

Whitehaven.—The L.G.B. has sanctioned the borrowing of £9,900 for electric lighting works.

Willesden.—The L.G.B. has sanctioned the application of the Council for power to borrow £139,640 for electric lighting purposes.

Withington.—At the last meeting of the U.D.C., the clerk stated that a letter had been received from the Electricity Department of the Manchester Corporation, stating that the Corporation were not connecting any further installations to their mains until they were in a position to say definitely when the current could be supplied from the Bloom Street generating station.

Wolverhampton.—The E.L. Committee has decided that four superheaters be fitted to the Lancashire boilers at the generating station at a cost of £600. The Local Government Board has sanctioned the borrowing by the T.C. of £1,000 for the provision of fittings for the lighting of private houses by electricity.

The salary of Mr. H. H. Howie, assistant electrical engineer under the Corporation, has been increased from £120 to £140 per annum, rising to £180.

ELECTRIC TRACTION NOTES.

Berlin—Zossen.—The Berlin correspondent of the *Morning Post* states that the military railway between Berlin and Zossen, a distance of 50 kilometres, has been the scene for more than a month past of experiments in fast travelling, conducted by Messrs. Siemens & Halske. A few days since the first trial took place with the electric motor carriages, built with the object of travelling at 200 kilometres an hour. A speed of 100 kilometres was attained with perfect safety. In the trials that are now taking place this speed is being gradually increased.

Brighton.—The Council on October 11th decided to construct a single line of tramway with passing places along the Dyke Road from the Seven Dials to The Drove, to be connected to the lines in New England Road.

The T.C. has before it what, to put it mildly, may be described as a remarkable proposition. It is a suggestion emanating from Mr. J. Coley-Bromfield, that the Council should apply for powers to construct and work an electric "mono-rail" railway between London and Brighton, at an estimated cost of £3,500,000, in accordance with a scheme prepared for a syndicate which that gentleman represents. The Committee simply resolved, however, "that the receipt of Mr. Coley-Bromfield's letter be acknowledged."

Chatham.—The work of laying the rails for the Chatham and District electric tramways is now being pushed forward rapidly. Double lines are constructed in the greater part of New Brompton, and down Chatham Hill into the High Street.

Darwen.—The new electric tram route between Darwen and Hoddlesden was formally opened on Saturday. Although this extension is less than two miles, it is an important connecting link between the two places. The work has been carried out from plans prepared by the borough engineer (Mr. R. W. Smith-Saville), and considerable difficulties have been surmounted in construction. The gradients vary from 1 in 10 to 1 in 70. The cars are from the works of Messrs. G. F. Milnes & Co., Hadley. The Mayor of Darwen, Mr. John Tomlinson, started the first service of cars on Saturday morning, and at the luncheon which followed, reference was made to the revolution which electric tramways were capable of making in places hitherto isolated. "The Borough and Electrical Engineers" was proposed by Alderman Eccles, who commended those officials for the expeditious manner in which the work had been carried out; and Mr. Smith-Saville, in reply, referred to the successful negotiation of the stiff gradients on the line.

Derby.—A scheme has been set on foot to promote a light electric railway from Derby to Nottingham and from Long Eaton to Alfreton, and application is to be made to the Light Railway Commission for the necessary provisional powers.

Douglas (I. of M.).—On Wednesday the Douglas T.C. decided, after discussion, to purchase the horse and cable sections of the Isle of Man Tramways and Electric Power Company's undertaking for £50,000. It was urged on behalf of the purchase that a profit over and above the £2,000 per annum lately received from the company as royalties would be earned. It is expected that the Bay section, at least, will shortly be converted to electric traction.

Gloucester.—A proposal to lay down a light railway between Gloucester and Worcester is finding much favour in the district affected.

Isle of Thanet.—The Margate Corporation has received the report of the inspector sent down by the Board of Trade to inquire into the accident which occurred to a car belonging to the Isle of Thanet (electric) Tramways Company in descending Fort Hill at Margate on August 10th last. The *Times* abstract says that the car was full of passengers at the time, and 27 persons complained of injury, two being removed to the hospital. Major Pringle, in his report, comes to the conclusion that the motor-man was responsible for the accident, in that, in the first place, he misapplied the electric current, and, in the second place, failed to use the reversing lever to reduce the speed of the car before reaching the sharp curve where it went off the line. It was only the second day on which the man had been called upon to act as motor-man in charge of a passenger car, and he failed in an emergency, for which his training of 16 days did not seem to have been calculated to fit him. The inspector considers, from the second accident that occurred on the hill on the same evening, that a sudden acceleration of speed may occur which cannot be quickly enough reduced to avoid danger of leaving the line or collision, and, therefore, some further appliance appears to be required to render such a sudden acceleration improbable. He thinks that is to be found in the slipper brake, and recommends that the cars should be fitted with it. The Board of Trade have sent down a draft of more stringent regulations for the working of the line.

Manchester.—The General Purposes Committee of the Salford Corporation have approved a report of the Tramways Committee recommending that the matters in dispute between that and Manchester be referred to arbitration on the lines indicated by Mr. Balfour Browne, K.C. The *Manchester Guardian* scarcely thinks the "opinion" goes far enough, and is disposed to think "that running powers over street tramways should always carry with them the obligation to accommodate local traffic." At present the greatest inconvenience is being caused to the public by want of such an arrangement.

Oldham.—In anticipation of the expiry of the tram leases this month, the Tramways Committee is pushing on rapidly with the erection of trolley poles along the principal thoroughfares. The longest length, from Hollinwood to Waterhead, is practically lined on both sides of the road by poles into the centre of the town.

Pontypridd.—The B.E.T. Company are seeking powers to construct and work a light railway from Tabernacle Chapel, Pontypridd, to the junction of the present tramways in Rhondda Road. An inquiry is to be held into the matter by the Light Railway Commissioners to-day, when the Pontypridd District Council will oppose the application.

Russia.—The Moscow correspondent of the *Standard* says that Americans have made a proposition to the city of Petersburg to take over the entire tramway system, and, under a 25 years' contract, relay and extend, in all directions, electric tramways in place of the horse cars. The capital, to be raised in America, is to be 100 million roubles.

Sedgley and Wolverhampton.—The track of the newly constructed electric tramway line from Sedgley to the Fighting Cocks, the boundary of Wolverhampton Borough, was officially inspected on Thursday last week by Col. von Donop on behalf of the Board of Trade. The length of the line is three miles, and it has been constructed by Mr. Geo. Law, of Kidderminster, who is also to carry out the contract for the construction of the extension line from the Fighting Cocks to Bilston. The inspector expressed his satisfaction with the line, and sanctioned a greater running speed than in any other district in South Staffordshire, viz., 10 miles an hour. The electrical equipment of the line has still to be inspected, but it is the intention of the B.E.T. Company to commence running on receipt of the B. of T.'s formal sanction.

Swansea.—The E.L. Committee proposes seeking powers to make a new electric tramway from the town out to Brynhyfrid.

Southport.—On Saturday evening the Tramways Committee entertained upwards of 300, men who had been engaged in the construction of the Southport electric tramways, to tea in Cambridge Hall.

Stroud (Glos.).—Progress has been made towards carrying out the proposed electric railway for Stroud and district. Mr. T. Nevins, the engineer, has interviewed most of the local governing bodies with gratifying results. At first there was a disposition on the part of these authorities to favour the narrow gauge, but Mr. Nevins very promptly assured them that he must have the broad gauge, or he would drop the undertaking. Then they caved in, and passed resolutions approving of the scheme. The Committee of the Gloucestershire County Council, specially appointed to consider the matter, has also approved the scheme.

Sunderland and South Shields.—On 8th and 9th insts. Colonel Boughey and Mr. H. A. Stewart, Light Railway Commissioners, sat at South Shields to consider the application of the B.E.T. Co., Limited, for power to construct a light railway from South Shields to Sunderland. A good deal of opposition was offered by interested parties, although all the different Councils through whose districts the line would pass gave it their entire support. The promoters were represented by Mr. Sidney Morse. The scheme, as outlined, showed that it would commence in King Street, South Shields, and proceed by way of Westoe and Harton, suburbs of South Shields, to Cleadon, a small village about four miles distant. Here the line would divide and one section would run to Fulwell, a suburb of Sunderland, and the other would go on to Whitburn, a quiet small watering place, frequented by visitors. Hence the line would be laid along the road to the south as far as the boundary of Sunderland. The company had at first sought to have running powers on the lines of the Sunderland Corporation to the centre of the town, but so strongly was this opposed that they agreed to abandon this part of the proposition. A somewhat analogous difficulty was presented at the north end of the system, that is, in the bounds of South Shields. Here the Corporation have obtained power to lay a line down from King Street to Westoe, but although this was obtained in 1896, the Corporation have taken practically no steps to carry out the work. Other opposition came from Whitburn. Here a number of residents objected to the line running through the front street on the ground that it would materially injure the place as a resort. This difficulty was got over by Mr. Morse, for the promoters, undertaking to make a divergence slightly to the north of the proposed line. In the course of the evidence it was stated that as showing the need there was for the railway, statistics had been made as to the number of people using the roads, and it was found that at a given spot on the Whitburn Road, along which the line would pass, there would be in the course of the year 1,000,000 passengers; on the Shields road there would be 600,000, and at Fulwell 670,000. The most serious opposition was that offered by the North Eastern Railway, which has a branch line running from Sunderland to South Shields. Mr. H. H. Watson, superintendent of the N.E. Railway, said they had suffered severely from competition with light electric railways. He mentioned that between Hartlepool and West Hartlepool there had been a decrease of 281,000 passengers in a year, a reduction equal to 39 per cent. of their traffic, that was entirely due to the electric trams. At Stockton it was even worse, for the decrease between Stockton and Newport was no less than 95 per cent., in fact, there was none of the traffic left. In regard to the North Shields and Whitley trams they had had the same experience; there the decrease was 14,000 passengers in a month, and although the distance was short it meant a loss of £1,300 per year. This witness, in answer to Mr. Morse, admitted that there was no train running to either Whitburn, Cleadon, or Fulwell, but said he could not shut his eyes to the through traffic. After a short consideration, Col. Boughey said they considered it as a through line, as even if it were not one now it could be made one without reference to the railway company in the future, and they thought it was a case that should be submitted to Parliament. So the matter rests at the present time.

Surrey.—At Croydon on the 10th inst. a conference, organised by the Wimbledon U.D.C., was held on the subject of the proposed extension of electric tramways into Surrey. The proceedings were private, but representatives were present from the Wimbledon, Croydon, Sutton, Epsom, Surbiton and Carshalton authorities.

The Surrey C.C. are about to hold a special meeting to consider their action with regard to the extensive tramway proposals affecting Surrey, and have been obtaining the views of the various local authorities concerned.

Sutton.—The U.D.C. have received plans of the tramway lines proposed to be constructed by the L.U.T. and the B.E.T. Co. A special meeting of the Council will be held on Wednesday, 23rd, to decide whether or not to oppose the principle of the introduction of tramways into the town.

Twickenham.—The U.D.C. having received the notices and plans of the authorised lines of the L.U.T., have returned the same on the surveyor reporting that the drawings are incomplete and inaccurate in many respects, and in some cases not in accordance with the agreement between the Council and the company.

Wallington.—Mr. Hulme, of the B.E.T. Co., explained the tramway scheme of his company to the last meeting of the Parish Council. On Mr. Hulme's withdrawal, there was a lively discussion; ultimately, a motion was carried *nem. con.* expressing the Council's opinion that it was undesirable that tramways should be introduced into the parish.

Walsall.—After a long discussion the T.C., on Monday, authorised the Tramways Committee to obtain tenders for the whole of the extensions previously decided upon, and to provide for the working of the tramways under the control of the Council. The resolution was only carried by a majority of one vote. A strong case was made out in favour of leasing the lines. It was pointed out that municipalisation would probably involve the Council in an expenditure of about £160,000; the existing debt on the borough (Councillor Powell stated) was £415,000, and probably another £100,000 would be required for the new municipal buildings. Consequently they had the prospect of their liabilities being increased to £676,000, and the principal and interest for the repayment of loans would amount to £7,200 per annum. The balance of opinion, however, favoured the Council bearing the whole burden.

Willesden.—The L.C.C. having invited the co-operation of the Council in the proposed double line of electric tramways, on the conduit system, from Marble Arch to Cricklewood, the latter body has resolved to take no action in the matter. It is considered that the underground electric line from Marble Arch to Cricklewood will be quite sufficient.

TELEGRAPH AND TELEPHONE NOTES.

Hull.—The Corporation has received a draft license for municipal telephones. A deputation from the Telephones Committee is visiting Glasgow to see the system there, and has power to appoint an engineer to carry through a scheme for Hull.

Liverpool Telephones.—A proposition for municipal telephones is shortly to be brought before the Council.

London Telephones.—At Tuesday's L.C.C. meeting, replying to a question by Mr. Pomeroy, Mr. Benn said the Highways Committee had no official information that the National Telephone Company was bringing any pressure to bear on the Post Office with regard to the rates to be charged to telephone users. The Committee had, however, asked the Post Office to call the Council into conference before making any arrangements.

Philippine Cable.—Reuter's agent at Washington says that on 11th inst. Mr. Knox, the Attorney-General, presented to the President and the Cabinet his report regarding the application of the Postal Telegraph Company for permission to land and lay a cable between San Francisco and the Philippines. He was of opinion that, under the law of 1866, any domestic company could land cables on the shores of the United States or of its possessions. The President and the Cabinet are convinced by the report that there is no ground for action by the Executive in this case, but the President will go into the subject more minutely with Mr. Knox, and will review the whole question in his message to Congress. The law of 1866 is the same as that under which the Postal Telegraph Company sought power to land a cable to Havana, a claim which was rejected by the then Secretary for War.

Southport Telephones.—The T.C. has resolved that application be made to the Postmaster-General for a license to establish a municipal telephone exchange.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Para-Maranham	March 1, 1900	
Cadiz-Teneriffe	Aug. 6, 1901	October 9.
Bissao-Bolama	Aug. 16, 1901	
Zanzibar-Mombassa	Sept. 27, 1901	October 15.
Cayenne-Pinheiro	Oct. 15, 1901	
Landlines :—		
"*Via* Hanekin" on Persian territory	Feb. 24, 1900	
Pekin-Kalgan	June 14, 1900	
Maimatchin-Kalgan	June 30, 1900	
Communication with Baranquilla and Cartagena towns of Venezuela	Dec. 8, 1900	
"	Oct. 31, 1900	
Saigon-Bangkok	Oct. 10, 1901	October 12.
Blagowestschenk-Khabarowsk	Oct. 15, 1901	

CONTRACTS OPEN AND CLOSED.

OPEN.

Amsterdam. — November 18th. Electrical overhead construction, rail bonds, &c, for the City Council. See "Official Notices" to-day.

Ashton-under-Lyne.—October 29th. Steel poles, bases, section boxes, and overhead line equipment for the Corporation. See "Official Notices" October 11th.

Army Contracts.—The Secretary of State for War gives notice that tenders for specific quantities of the undermentioned articles will probably be invited from time to time during the next 12 months, namely:—Acids, Electrical Instruments, Telegraph Cable. See "Official Notices" to-day.

Barking Town. — November 12th. An electrically-driven loco. crane, and permanent way for the U.D.C. See "Official Notices" to-day.

Batley.—October 18th. Lancashire boilers, economiser, condensing plant, piping, crane, &c., for electricity works. Engineers, Lacey, Clirehugh & Sillar, Westminster.

Bootle.—October 23rd. Wiring the extension of the Town Hall buildings for the Corporation. Specification and the form of tender from the Borough Electricity Works, Pine Grove, on payment of one guinea.

Boulder City.—November 23rd. The Council invites tenders from manufacturers for the construction of a tramway system, plans and specifications of which are to be seen at the office of the Agent-General, London. See "Official Notices" September 20th.

Blackpool.—October 21st. Tramway poles, cables, overhead work, electric car equipment, &c., for the Corporation. See "Official Notices" September 27th.

Christiania.—October 30th. Telegraph materials for the Norwegian State Railways Department. Particulars may be examined at the Commercial Department of the Foreign Office.

Darlaston.—October 18th. Construction and reconstruction of 8 miles of tramways between Wolverhampton and Darlaston, for the British Electric Traction Company, Limited, on behalf of the Wolverhampton District Electric Tramways, Limited. The electrical equipment of the tramways not included. Chief Engineer, Donington House, Norfolk Street, W.C.

Dudley.—October 25th. Pipework for electricity works. See "Official Notices" October 11th.

Dundee.—October 18th. The Gas Commissioners want tenders for electric motors. Mr. W. H. Tittensor, electrical engineer.

East London (S.A.).—November 26th. Tenders to Mr. R. N. Moir, Town Clerk, for 50-KW alternator and engine. London agents, Dyer & Dyer, Aldermanbury, E.C.

Great Western Railway.—October 21st. The directors want tenders for a year's stores, including (17) India-rubber goods; (18) Telegraph instruments; (19) Telegraph apparatus; (20) Copper wire, G.P. wire, &c.; (21) Telegraph ironwork and tools; (22) Telegraph drysalteries; (23) Electric light carbons; (24) Electric lamps, incandescent; (51) Telegraph poles and yellow pine.

Ilford.—October 29th. Water-tube boiler, 550-KW. high speed steam dynamo, switchboard, &c., for U.D.C. tramways. See "Official Notices" October 11th.

L.C.C.—October 31st. Electric lighting of the Homerton, West Hampstead, East Greenwich, and Perry-Vale fire stations. See "Official Notices" October 11th.

Leyton.—October 26th. Multipolar dynamo (450-KW.) and a balancer, for the U.D.C. See "Official Notices" October 11th.

Limerick.—October 28th. Cables, arc lamps, Westinghouse engines, dynamos, boosters, and Dowson gas plant for the electric lighting. See "Official Notices" October 11th.

Manchester.—Two 6,000-H.P. triple-expansion engines, two 3,750-KW., three-phase alternators, 48 motor-generators for Stuart Street generating station, and sub-stations. See "Official Notices" October 11th.

Newport (Mon.).—October 21st. Coal handling winches, piping, switchboard, cables, cable ways, overhead construction, electric motor car repair shop equipment, and steel chimney shaft for the tramways and power supply undertaking. See "Official Notices" September 20th.

Oldham.—November 5th. Cables, joint boxes, motor booster, motor-generators, switchgear, &c., for the electricity works. See "Official Notices" to-day.

Rochdale.—November 8th. Boilers, economisers, stokers, condensers, &c., for the electricity works. See "Official Notices" to-day.

Sardinia.—Electric light and power for all the mines in Sardinia. Contractors wishing to supply the necessary material should place themselves in communication with Mr. G. Merlo, expert of the Mining Association of Sardinia, at Iglesias.

Spain.—October 28th. The municipal authorities of Jaca (province of Huesca) are inviting tenders until the 28th inst. for the concession for the electric lighting of the town. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Jaca (Huesca).

Spain.—November 4th. Tenders are being invited until November 4th by the municipal authorities of Burgo de Osma (province of Soria) for the concession for the electric lighting of the town during a period of five years. Tenders are to be sent to El Secretario del Ayuntamiento de Burgo de Osma (Soria), whence particulars may be obtained.

South Lancashire.—November 4th. High and low tension cables, stoneware pipes, &c., for the South Lancashire Electric Traction and Power Company. See "Official Notices" to-day.

Stourbridge.—October 18th. Construction of 2½ miles of tramways at Stourbridge, for the British Electric Traction Company, Limited. Electrical equipment not included. Specification, &c., £5. Chief engineer of the company, Donington House, W.C.

Swindon.—November 12th. Boilers, cooling tower, 10-ton crane and other plant for electricity works. See "Official Notices" October 11th.

Woolwich.—The U.D.C. is about to issue advertisements for sundry electrical instruments required on the completion of the electric lighting works.

CLOSED.

Abersychan (Mon.).—The U.D.C. have accepted the tender of Messrs. Edwards & Armstrong to provide for the public lighting of Carnarvon by electricity.

Bangor.—The City Council has accepted the following tenders:—

J. Watkin Jones, concrete work	£38 10 0
Babcock & Wilcox, Limited, steam pipes..	82 13 6
Meldrum Bros., induced draught plant	34 0 0
Dorman & Smith, extension of switchboard	98 10 0

Batley.—The Electric Traction Committee has recommended the T.C. to let the contract for the laying of the permanent way for the new electric tramways to Messrs. F. Graham Bros., of Huddersfield, for £30,000.

Erith.—The U.D.C. has adopted an E.C.C. alternator, driven by a Parsons engine, for its electricity scheme.

Germany.—Herr C. Pippig, of Leipzig Gohlis, submitted the lowest tender to the Prussian State Railway authorities at Coblence for the supply and erection of six electric luggage lifts.

Hebburn-on-Tyne.—Messrs. Warren, Beattie & Co., electric power engineers, of Middlesbro', have secured the contract for the supply and erection of the whole of the motors and cabling in connection with the electric power installation about to be put down by Messrs. R. Stephenson & Co., Limited, at their shipyard at Hebburn-on-Tyne. This comprises 39 motors varying in power from 6 to 50 H.P., the main switchboard, distribution boards, and all the cabling in connection therewith. Messrs. Warren, Beattie & Co. have also secured the order for the lighting of the shipyard, various shops and offices. The lighting installation comprises 68 arc lamps of 2,000 C.P. each, and over 550 incandescent lamps.

Heckmondwike.—The U.D.C. has accepted the offer of Messrs. J. H. Taylor & Co., Huddersfield, to wire consumers' premises on the extended payment system. It was agreed to alter the Council's regulations so as to provide an alternative charge of 2½d. per unit for energy used for motive purposes. With regard to Messrs. Taylor's offer, it was stated that payment would be allowed to extend over three years, interest to be charged at the rate of 5 per cent.,; people wishing to pay off sooner would be permitted to do so.

Huddersfield.—The Corporation, on 16th inst., accepted the tender of the Telegraph Manufacturing Company for electric lighting cable at £67 11s. 6d., and at 7s. 6d. per lb. for I.R. strip.

Ilford.—The Council has given a contract to Messrs. Macartney, McElroy, for the track and permanent way for the tramway. The cost of the contract is £66,000, and the work has to be completed in nine months.

Kirkcaldy.—The T.C. has accepted the tender of Messrs. Henley's Telegraph Works, London, for mains and feeders, amounting to £11,239; also Messrs. Crompton & Co.'s offer for arc lamps, £546 6s.

Manchester.—The City Council has awarded the contract for concrete foundations and two chimneys at the Stuart Street electricity works to Messrs. C. H. Normanton & Sons, of Manchester, at £6,459.

Poplar.—The Council has accepted the following tenders:—

Messrs. Babcock & Wilcox, boilers and condensing plant	£3,485
B.I.W. Company, cables, &c.	10,522

Willesden.—Last June the Metropolitan Electric Supply Company, Limited, advertised for tenders for the supply of two 3,000-KW. two-phase steam generators; these machines were required as extensions to the Willesden power-station of the company, which is at present equipped with five Westinghouse two-phase steam generators of 1,500-KW. each, generating current at 500 volts per phase and 60 cycles. A bid for this work was made by over 40 firms having works all over the world; and the successful tender was that of Messrs. Witting Brothers, Electrical Engineers and Contractors, Limited, who have taken the order for both plants with Sulzer engines and Kolben generators. The first plant is to be delivered and running by next July, and the second in the following year. Each will be capable of generating 3,500 KW. at a speed of 75 revolutions per minute. A noteworthy feature is that the alternators will generate current at 11,000 volts per phase directly in their own armatures; they will have to work in parallel with the Westinghouse machines, the pressure of these being raised by means of transformers.

(*Continued on page* 639.)

WALTHAMSTOW ELECTRICITY WORKS.

The electricity works of the Walthamstow Urban District Council were formally opened on September 20th. Councillor J. R. Friend, the chairman of the Electric Lighting Committee, who presided, gave a short history of the undertaking, in the course of which he mentioned that it was the first large central station in this country to be equipped with generators direct coupled to vertical gas engines. Mr. James Enright, the consulting engineer to the Council, then proceeded to explain the working and uses of the machinery and apparatus in the station.

Votes of thanks to the chairman of the Council, the chairman of the Electric Lighting Committee, the consulting engineer, and the contractors having been carried, a move was made to the machinery hall, where Mrs. Friend, the wife of the chairman of the Electric Lighting Committee, switched on the light by means of a silver switch presented by the contractors.

Messrs. Frank Suter & Co., Limited, were responsible for carrying out the contract for the whole of the plant, which at present consists of two Dowson gas producers, three generating sets, balancer, three boosters, and two batteries, together with the main switchboard and all subsidiary machinery.

Buildings.—The works are conveniently situated on a site adjoining Hoe Street station, G.E.R. The buildings were erected by the Council's own workmen, from designs by Mr. Enright. The main building contains the engine room, 123 ft. long × 46 ft. wide, adjoining which is the battery room, 73 ft. long × 20 ft. wide, repair shop, stores, &c. The gas house and coal shed form a separate building adjoining the engine room. On the first floor are the engineer's offices, meter and testing room, drawing office, and committee room.

Gas Plant.—The engines are driven by Dowson gas, which is a cheap fuel gas made by passing superheated steam, mixed with air, through red-hot fuel in vertical gas generators. The gas is made as quickly as it can be consumed; but to ensure a steady pressure, and to cover any fluctuations in the rate of production, it is passed into a gasholder before it goes to the engines. The gas plant consists of two Dowson gas generators, each capable of serving a maximum of 250 B.H.P. Each generator has a set of cooling pipes, a hydraulic box, two coke scrubbers, a washer, and a sawdust scrubber. Both sets can be worked together or separately, as may be required. There is also a special contrivance, by means of which the rate of producing the gas is regulated automatically by the rise and fall of the gasholder, to suit the varying rate of consumption.

By this method of working, the cost of the gas, including fuel, wages and the usual repairs, is about 2½d. per 1,000 cubic feet. It is, however, necessary, to use about four times the quantity of this gas, as compared with ordinary town gas, to obtain the same engine power, so that the equivalent of 1,000 cubic feet of town gas costs about 10d., whereas the town gas at Walthamstow costs 3s. 10d. per 1,000 ft.

Another interesting comparison is the fact that with Dowson gas the actual fuel consumption of the engine is only about 1 lb. per B.H.P. per hour; whereas a non-condensing steam engine of the same power and of the best up-to-date design requires from 2½ to 3 lbs. of fuel per B.H.P. per hour. In addition to the low fuel consumption per H.P., when the plant is working, it is much more economical than a steam plant during the stand-by hours. The low cost of repairs is also a special feature of the Dowson gas plant: it is much less than the repairs and cleaning of steam boilers of the same power. There are over 60,000 H.P. actually working by Dowson gas, so that it has been thoroughly tried.

Gas Engines.—The main power installation consists of three gas engines direct-coupled to "Helios" multipolar generators; the gas engines are of the Westinghouse three-cylinder vertical type, fed with producer gas. They are each of 110 B.H.P. capacity, and are of the type which has acquired, during the comparatively short time it has been on the market, a considerable popularity. The engine has three single-acting cylinders working on the four-cycle principle, that is, each piston receives one impulse every other revolution. The pistons being connected to cranks on the main shaft set at angles of 120° with each other, the main shaft receives one propelling impulse every two-thirds of a revolution. A mixing chamber forms a part of the engine, and in this the gas and air supplied are mixed in the correct proportions for giving the maximum effect to be secured from the quality of gas available. Valves with definite and convenient hand adjustments are placed at the gas and air admissions to the chamber for this purpose. A valve between the mixing chamber and the admission valves of the cylinders regulates the supply of this mixture to the engine; this valve is controlled by a sensitive governor of the fly-ball type. The governing arrangement ensures the maximum number of impulses to the engine, no matter what the load, giving a speed regulation within 2 per cent. for all changes of load.

It is claimed that this principle of governing ensures a great economy of fuel, the amount of gas used being, as nearly as possible, directly proportional to the engine load. Another point to be remembered is that by this principle a practically noiseless exhaust is secured, a matter which is frequently of great importance. This is so in the case under notice, where the central station at Walthamstow is surrounded by residential buildings. Vibration also is practically absent. The cylinders are water-jacketed, the water being used over and over again, with very little loss, passing from the cylinders through a compact vertical cooling tower. The water circulation is maintained by centrifugal pumps direct coupled to "Helios" electric motors; these pumps are in duplicate to ensure reliability in working.

The engines are started by compressed air supplied either by an electrically-driven air compressor, or by other compressors driven by the engines. The starting system is so arranged that one man can easily start any engine by operating a valve, the time required being even less than for a steam engine of equal size. The explosive mixture in the cylinders is ignited by an electric spark, the current for this purpose being supplied either by small sparking dynamos direct coupled to motors, or by primary batteries. These circuits are arranged so that should one fail the other is automatically brought into action.

Dynamos.—The dynamos, as before mentioned, are direct coupled to the engines, on a combined bedplate, and are of the well-known "Helios" multipolar type supplied by Messrs. Frank Suter & Co., Limited. These machines are shunt wound, and are rated to give 150 amperes at voltages ranging between 460 and 560, and at a speed of 260 r.p.m., the regulation being entirely effected by altering the shunt resistances.

The circular magnet frame is of very substantial build, as can be seen from our view, and is divided horizontally into two parts. The two halves of the framework are carefully machined and bolted together, so that the top half can easily be removed for the inspection of the armature and other parts.

The magnet poles are of soft steel of the highest permeability, and are bolted to the cast-iron magnet frame, being set in position by a feather on the pole-piece which slides into a groove in the magnet frame. The pole shoes are accurately bored out when in position.

The field coils are machine-wound on well insulated formers, which are held rigidly on the poles by the pole shoes. The windings consist of the best cotton-covered wire of 100 per cent. conductivity.

The armature is of the slotted drum type. The core is built up of very thin punched discs of the best Swedish charcoal iron, mounted on a strong cast-iron spider, which is securely keyed to the shaft. Each disc is slotted on the periphery to receive the windings, then shellacked and separated from the next by tissue paper. The slots in the core are smaller at the top than at the bottom, the conductors being wedged in with insulating material, so as to dispense with binding wires.

The commutator is built up of hard drawn copper segments, mounted on a cast-iron core, insulated from the latter and from each other by the best clear mica. The diameter is exceptionally large, and the segments of ample depth to allow for considerable wear. The commutator is

entirely self-contained, and is easily removable after disconnecting the windings.

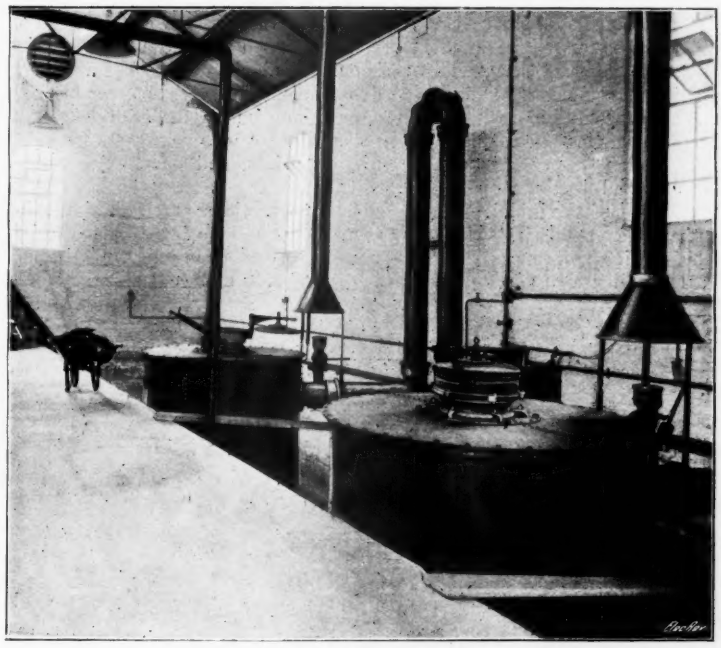
The brush rocker ring is carried and guided by small bracket arms projecting from the magnet frame, so that it can be rotated round the commutator by means of a hand-wheel and worm gear. During the running of the machine no adjustment of the brushes is necessary, even with the widest variation of load.

The brush-holders are of very simple construction. The prism-shaped carbon brush is held rigidly by the holder, and the pressure on the commutator can be varied by means of a screw and spring provided for the purpose. The current is not conveyed by the spring, but by a special flexible conductor.

The bearings are cast separately, and are provided with self-adjusting "brasses," which ensure perfect alignment; they are fitted with ring-type lubricators. The "brasses" are lined with a special quality of white metal, and are of ample dimensions, to ensure cool running.

Balancer and Boosters.—The balancer set consists of two machines of the "Helios" four-pole type, coupled together with a flexible coupling. Each machine has an output of 20 KW. at 230 to 250 volts, and is capable of dealing with an out-of-balance current of 100 amperes.

The fields of these two machines are cross-connected with opposite sides of the three-wire system, thus reducing the hand regulation to a minimum. The balancer machines are simultaneously started by a double motor starter, all starting resistance being cut out of the armature circuits on the machines reaching their full speed. A shunt regulator is inserted in each field circuit.



Walthamstow Electricity Works.—The Dowson Gas Producers.

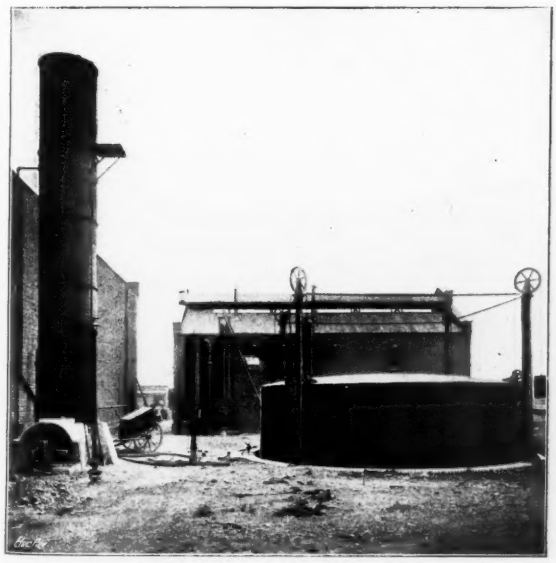
The two motor boosters are of the same type as the balancers, and are coupled in the same manner. Each of the generators is capable of boosting a current of 200 amperes, or 300 amperes if necessary, from 10 to 130 volts. These boosters are not only used for charging the batteries, but may also be employed for boosting up or down, *i.e.*, raising or lowering the voltage of any one or several of the feeders. Shunt regulating resistances are inserted in the fields of the generators. The booster motors are driven by current from the bus bars at 460—560 volts, and are controlled by combined starting and regulating resistances.

There is also a "milking booster," consisting of two "Helios" two-pole machines, rated to give 200 amperes at any pressure from 2 to 8 volts. It is to be used for the separate charging of "backward" cells. This booster is regulated on the same principles as the above-mentioned sets.

All the balancer and booster sets are mounted on iron girders sunk into solid concrete foundations.

Batteries.—There are two Tudor batteries, composed of 142 cells each. They are 17-plate cells, contained in lead-lined wood boxes, and are mounted in two tiers on glass insulators. Further insulation is effected by the battery stands being mounted upon large porcelain oil insulators. The capacity of the cells is 720 ampere-hours.

Travelling Crane.—A 10-ton overhead traveller, by Messrs. Carrick & Ritchie, having a span of about 46 ft., and fitted



Walthamstow Electricity Works.—Outside View, showing the Gas-holder.

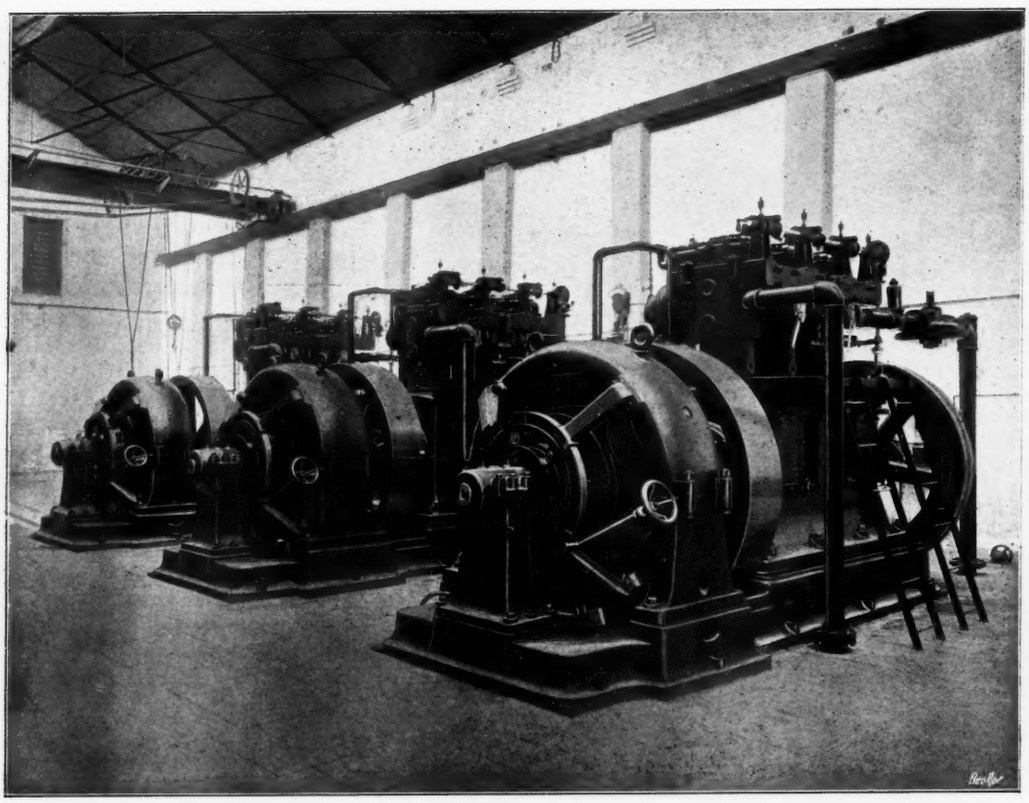
Walthamstow Electricity Works.—Laying the Mains.

with automatic brake and quick lift for loads less than 1 ton, traverses the whole length of the engine room.

Switchboards.—The main switchboard, made by Messrs. Frank Suter & Co., Limited, at their London works, is of white marble, in seven panels, together measuring 24 ft. 6 in. long × 7 ft. high. It is of the usual three-wire pattern, and is arranged for the connection of four dynamos, six feeders, two batteries, one balancer, and two boosters. The middle wire connections are placed on the centre panel, the middle wire being earthed through a recording ammeter. On this centre panel all meter switches, &c., in connection with the balancing transformer, together with starting and regulating switches for the same, are fixed.

The positive and negative booster and battery apparatus are arranged on panels to left and right of the middle panel. The actuating handwheels for the battery regulating switches on these panels are connected by shafting and mitre wheels with the switches, which are fixed in the battery room. These handwheels are geared to indicators placed at the back of the board in such a manner, that numbers corresponding with the position of the switches appear at small holes above the handwheels. The battery regulating switches are of Messrs. Suter's parallel type, of 33 contacts, which, with bus bars, are mounted on white marble, and being in the battery room, are protected from acid fumes by glass-fronted and airtight wooden cases. The instruments and apparatus in connection with the dynamos and feeders occupy the four outermost panels, the positive side being to the left, and the negative to the right of the centre panels. A "Helios" automatic minimum cut-out is in circuit with each dynamo, and these cut-outs are interlocked with shunt switches, which, when the main circuit is opened, close the field through a non-inductive resistance. Fuses are inserted on both poles of the dynamos. These fuses (and all others on the board) are of the "Helios" high voltage cartridge pattern, so that in the event of a fuse melting, a spare cartridge can be immediately substituted. Each dynamo is connected through an ammeter with a plug bar in the usual manner. The dynamo and feeder bars are placed vertically on the front of the panels, the bus bars being fixed horizontally at the back. These are of wrought copper, of 1 in. sectional area for the vertical, and 1¼ in. for the horizontal bars. From the bars, the feeder current passes through fuses, switches and ammeters to the network. In addition to the Weston ammeters and Kelvin voltmeters, and placed on the bottom of the panels, there is one Chamberlain & Hookham ampere-hour meter for each dynamo, one for each booster motor, and one reversible ampere-hour meter for each battery. There are also two registering hot wire voltmeters to register the voltage at the feeding points, and one for the station mounted on the middle panel.

The connections at the back of the board are made of bare copper rods, coloured blue or red according to their polarity. The arrangement of placing the battery regulating switches in the accumulator room obviated the necessity of bringing 66 cables from the regulating cells to the switchboard. The result of this is that there are no straggling cables interfering with access to the back of the board, as is the case in so many central stations.



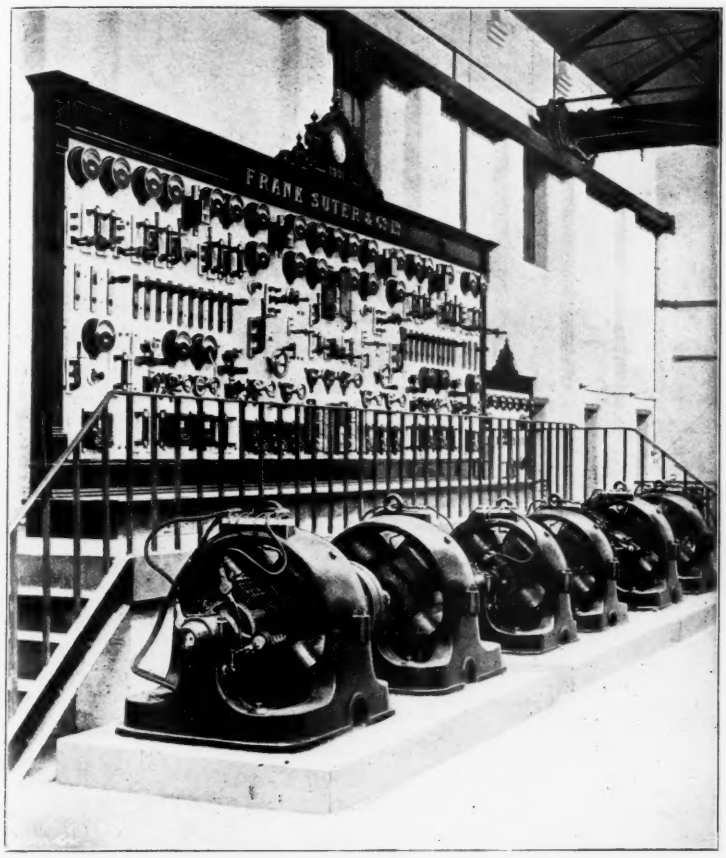
Walthamstow Electricity Works.—View of Engine Room, showing Westinghouse Gas Engines Direct Coupled to Helios Generators.

There is also a station-lighting and power-distribution board, consisting of three panels of white marble, with the necessary switches, ammeters, fuses, &c. From this board are controlled the different motors coupled to pumps, air compressors, igniters, and other apparatus.

Street Lighting and Cables.—From the generating station five concentric feeders proceed to feeding points, from which the current is distributed on the three-wire system at a pressure of 460 volts between the two outers. The middle wires are all joined up and connected to two middle wire feeders, which run back to the generating station, where they are put to earth. Consumers' terminals are connected to the middle wire and one of the outers, so that the voltage between lamp terminals is 230. All the cables are laid on the solid system in vitrified earthenware troughs, 18 in. long;

64 Tee and 4-way link disconnecting boxes have been laid in brick pits, and protected by Henley's patent ventilating frames and covers. Over 200 boxes have been laid for the connecting of arc and incandescent lamps. The whole of the underground work has been carried out for Messrs. Henley under the supervision of Mr. D. S. Strong, whose design of box has been used throughout.

At present the principal streets are lighted by 63 arc lamps of 1,400 c.p. each, run in series of nine across the two outers of the three-wire network. On each arc lamp column are also two incandescent lamps placed in series with the outers. Both arc and incandescent lamps are controlled by switches placed in the base of one end column of a series, so that on switching out the arc lamps the incandescent lamps are automatically switched in, an independent switch wire for the latter being run to the column for that purpose. In the less important thoroughfares the existing gas standards have been converted for incandescent electric lights, which are so arranged that they may be switched on or off from central positions.



Walthamstow Electricity Works.—View of Switchboard and Boosters.

The arc lamps and pillars were supplied and fixed by Messrs. Oliver & Co., Limited; Messrs. W. T. Henley and Co., Limited, being the contractors for the underground mains, conduits, &c.

The Urban District Council may be congratulated on the fact that although the station has only been open three weeks, no less than the equivalent of 5,000 8-c.p. lamps is connected, and applications have been received for an additional 7,000 lamps. There is also a fair demand for current for power purposes. Extensions and additions to the plant are therefore necessary, and we understand that the Council has already placed an order for a fourth generating set with Messrs. Suter & Co.

ELECTRIC LIGHT FITTINGS.

The G.E.C. Showrooms.

In the capacity of chroniclers of the development of electric supply, it falls to our lot every week or two to report that this, that, and the other town has added so many hundreds of new consumers to its clientèle, so many thousands to its lamps alight, and so many tens or hundreds of thousands of units to the energy supplied during the past year. These figures are becoming so usual to all of us that unless specially in search of statistics we pass them over with a nod and a casual remark to the effect that the headway made is little more than was to be expected — no better than it ought to be. That, of course, is when we look at the matter from a lighting supply point of view. But let us take

Fig. 1.—A Hall or Vestibule Light in Polished Brass.

Fig. 2.—A Dining or Drawing Room Pendant, Richly Gilt and Chased Ormolu Brass Work.

Fig. 3.—A Reversible Fitting for Hospital Wards.

another stand and look at the matter therefrom. What a great deal this development all means to the numerous industries which are devoted to the manufacture of boilers, engines, generators, switchboards, &c., and other station plant equipment extensions which the increased demand for electrical energy necessitates. The engineer who throws his whole heart and soul into energetically pushing the supply of electricity, not only benefits his locality or his company, bringing credit to himself meanwhile, but he is helping forward our national manufacturing industries, benefiting masters and men in a very real and practical way.

Sometimes when the development of these stations is in mind we are apt to disregard the amount of capital that is being expended every year in the fitting up of private residences and public buildings. The amount of material employed and the labour of fitters and wiremen involved, are not by any means negligible quantities, for those who specialise in these sections of electrical industry find themselves overwhelmed with business at times, although, unfortunately, we have frequently had to refer to the tendency to price cutting by those anxious to secure a footing. The manufacturer of wires and of a thousand accessories, as a rule, is also finding a ready market, but there is one class of work to which it is our wish to draw especial attention in this article, and that is the design, manufacture, and sale of electric light fittings. No sooner does the network of supply mains reach the vicinity of public buildings, churches, or large residences of any consequence, than the officials of these respective places set to work to have the buildings electrically lighted and fittings, as artistic and ornamental as the circumstances and the purse permit, are selected. For theatres and for country mansions it is often considered best to put down an isolated generating plant, but the demand for fittings is not interfered with by such considerations as these. The fittings manufacturer has a hand in every installation that is carried out.

In spite, however, of the fact that electric lighting is now so advanced, and that many thousands of new designs have been brought out during the past 10 years or so, there is frequently a difficulty, even with so many stock designs from which to select, in meeting the wishes and satisfying the tastes of the intending user without making special designs.

Tastes in fittings change with the times, as do most things, and something new is always wanted. We have recently had an opportunity of inspecting the arrangement of several electric fittings departments in London, and some notes regarding certain cases have already appeared in these columns. The latest of such to claim our attention was at the Queen Victoria Street establishment of the General Electric Company (1900), Limited. We ought first to mention that the company's fixture works as they now stand —leaving out of consideration, of course, the new factories which are building for electrical machinery manufacture —employ 400 hands continuously and exclusively upon the many different classes of work entailed in the manufacture of electric light fittings. It is only in cases of special emergencies that designing is done there, a room being set apart on the top floor (to procure the best lighting effect) of the G.E.C. London offices expressly for that purpose under the competent supervision of their artist. Under the very courteous pilotage of one of the directors of the company, we were afforded an opportunity of investigating the ins and outs of the organisation, and method of operating the department. Every morning's post brings a number of applications for designs to be submitted of fittings suitable for this church, that country mansion, a synagogue, town hall, corporation public lighting, tramway and railway car fixtures, &c., &c. It is a vague order, but the designer soon gets to work. Be it a church, something severe or austere in outline, must be produced; be it a theatre, something free and elaborate, even rollicking in style; for a council chamber, sometimes sombre, sometimes gay and festive, a happy medium between

Fig. 4. Fig. 5. Fig. 6.

Fig. 7. Fig. 8. Fig. 9.

Fig. 4: Black Iron Bracket for outside lighting. Fig. 5: W.I. Street Lantern with watertight switch. Fig. 6: Polished brass bracket (one light). Fig. 7: An effective three-light bracket. Fig. 8: A convenient standard. Fig. 9: A simple pale lacquered brass bracket.

G.E.C. Electric Light Fittings.

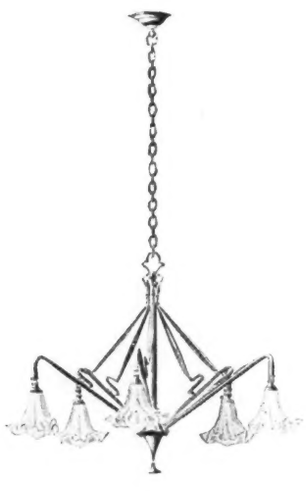


Fig. 10.—An Elegant 5-Light Electrolier.

Fig. 11.—An Artistic Window Fitting in Polished Brass.

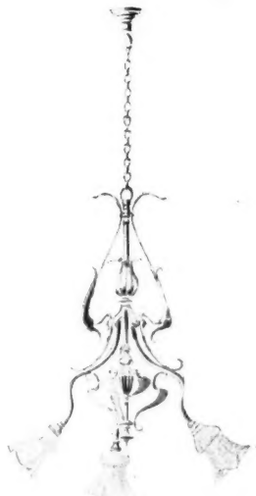


Fig. 12.—3-Light Electrolier.

G.E.C. Electric Light Fittings.

In the church and theatre designs must be the controlling principle; for a mansion something rich, elaborate, and handsome for drawing rooms, plainer, yet pleasing, for dining rooms or billiard tables, and so on in the same way for all other buildings in which the electric light fitting has a place. Nothing must be done to hinder the best illuminating effect being obtained. These and many other

similar considerations have to be for ever ready within the designer's mind for use when drawing out some new work of art.

Nowadays the G.E.C. are getting away from the indefinite, the involved, and leaf work is giving place to a clearer outline in character and design. The new catalogue which they have just issued for drawing the attention of architects, electricians, &c., to the new designs shows this very plainly. The new series of designs are a distinct departure from the general thing. Eccentric quaintness has been avoided, and also wild extravagance and eccentricity, the result being a series of inexpensive, simple, dignified and artistic designs. The range of prices in the book is from a simple 4s. bracket to a handsome £80 electrolier. It is calculated that the new line will never clash with any future changes that may come over decorative art.

In the course of our round of the showrooms, some of which are fitted up as dark rooms for inspection of the more expensive lines under electrical illumination during the hours of daylight, we were led to form the opinion that few, if any, other showrooms of the kind in London were so large, so commanding, or so beautifully and conveniently arranged. The varieties of brackets, electroliers, lamp standards, pendants, &c., include specimens finished in polished brass or copper, natural bronze, oxydised silver, and hammered iron, either black, or artistically finished in armoured steel. These finishes are sometimes combined with brass or with copper, bright or dull, just as design or taste requires. We give a few selected specimens of illustrations from the "Fixtures" catalogue. The G.E.C. also have showrooms for exhibiting their fittings designs at Glasgow, Newcastle, Manchester, Birmingham, Cardiff and Dublin.

The company do a good deal of public lighting work, and amongst recent contracts for street lighting installation work, arc lamps and posts, &c., may be mentioned Rathmines, Pembroke, Queenstown, Hornsey, Fulham, &c. We illustrate a very neat, compact, and most serviceable fitting for incandescent street lighting. It will appeal to Town and Urban District Councils, where conversion from gas to incandescent street lighting may be contemplated. The design has been produced to allow everything necessary to be done with the minimum of trouble, and the maximum saving of time. The hood and reflector of the lantern have the incandescent lamps securely attached to them, and are hinged in such a manner, that the whole of the upper part of the fitting can be swung back to allow facility for cleaning and changing the lamps; furthermore, to render this matter easier still, and less dangerous, the ring in which the well glass is held is pivotted in such a manner, that an employé, standing on a ladder, instead of having to reach over the well glass to clean it, is enabled to cant it in such a position that he can clean the glass in one-half the time necessary in the designs of other incandescent street fittings. The company are at present engaged upon several large installations of these fittings.

CONTRACTS CLOSED.

(*Continued from page* 633.)

Exeter.—The City Council, at a special meeting on Monday, considered tenders for equipping the new electric light and power station about to be erected by the Corporation at the Basin, adjoining the end of the ship canal. The specifications were by the Council's electrical engineer, Mr. H. D. Munro, and tenders were invited. Over a hundred tenders were received, and the E. L. Committee asked the President of the Institution of Electrical Engineers to submit the names of three persons competent to advise the Council; but that gentleman having replied that he was forbidden by the rules of the Institution to comply with the request, the Committee selected Mr. Robert Hammond, and submitted the tenders, electrical engineer's scheme, and alternative plans to him. Mr. Hammond, in his report, recommended the adoption of the two-phase system in place of the single-phase now in use, and for Sec. C. favoured the tender of Messrs. C. A. Parsons & Co., for turbine plant, for £11,685 (two 500-KW., one 200-KW., and one 100-KW.). The summary of Mr. Hammond's analysis showed:—

(A) Recommended tenders under sectional headings.

Section A, Babcock & Wilcox, Limited	£6,728	15 0
" B, " "	3,859	0 0
" C, C. A. Parsons & Co.	11,685	0 0
" D, S. Z. de Ferranti, Limited	1,424	15 0
" E, Babcock & Wilcox, Limited	3,519	0 0
" F, " "	764	12 0
	£27,981	2 0

(B) If whole job given to the British Westinghouse Electric and Manufacturing Company, Limited.

Sections A to F, British Westinghouse Company	£28,989	0 0

(C) If Sections C and D only given to British Westinghouse Company, Limited.

Section A, Babcock & Wilcox, Limited	£6,728	15 0
" B, " "	3,859	0 0
" C } British Westinghouse Company ..	12,785	0 0
" D } " " ..	300	0 0
" E, Babcock & Wilcox, Limited	3,519	0 0
" F, " "	764	12 0
	£27,956	7 0

Mr. Hammond, in a supplemental report, said he did not share the opinion of those who deemed it worth while paying some one contractor a matter of £2,000 for taking the responsibility of the whole job. The best policy was to keep the £2,000 in hand, and spend a portion of it in seeing that in every detail the high-class plant tendered for was obtained. He concluded by urging the Council to consider whether or not it was advisable to substitute low pressure generating and feeding for the existing high pressure transformer system, as the present would be their last opportunity of making the change. For himself he did not express an opinion.

The Electric Lighting Committee recommended to the Council that the contract for equipment of the station be placed in the hands of one firm; that the two-phase system be adopted (as advised by the city electrical engineer, Mr. H. D. Munro); and that, subject to the consent of the Local Government Board being obtained to the raising of the money by loan, the complete tender of the British Westinghouse Company of £28,989, with an addition of £718 for larger boilers (£29,707 in all) be accepted.

To the motion for the adoption of the Committee's report, Councillor Munro moved an amendment that the offer of Messrs. Parsons for £27,981 2s., be accepted, the mover pointing to the increasing number of turbine engines now being used for electric lighting purposes, and expressing the belief that Exeter would save £500 a year by the adoption of that type.

After more than three hours' discussion the meeting was adjourned for a fortnight.

Middlesbrough.—The Council last week accepted the following tenders:—

Askham Bros. & Wilson, Limited, mechanical coaling apparatus ..	£791
A. J. Cooke, engine foundation, boiler setting and flues	243
Nalder Bros. & Thompson, Limited, extension of switchboard ..	—

The L. G. B. has sanctioned the additional loan of £34,100 required for electricity supply purposes.

Southwark.—The E.L. Committee has recommended the acceptance of tenders as follows:—

B.T.H. Company, meters, boards, &c.	£115
T. & T. Vicars, mechanical stoker	265

Wolverhampton.—The T.C. has accepted the tender of Messrs. Thomas Parker, Limited, for the supply of a reversible booster (£340.)

FORTHCOMING EVENTS.

Friday, October 25th.—At 5 p.m. Physical Society; meeting at the rooms of the Chemical Society, Burlington House. Paper "On the Variation with Temperature of the Thermo-electromotive Force and of the Electric Resistance of Nickel, Iron and Copper, between the Temperatures of −200° and +1,050°," by Mr. E. P. Harrison.

At 8 p.m. Institution of Junior Engineers; annual general meeting at the Westminster Palace Hotel, for the presentation of the report of the Council and election of officers for twenty-first session.

NOTES.

Yorkshire College Engineering Society.—The first meeting of the sixteenth session was held on Monday, when Prof. J. Goodman delivered his presidential address, the text being "The Life and Work of John Ericsson." The syllabus foreshadows the following arrangements:—

Monday, October 28th.—"The Wigzell-Balanced Engine," by Mr. R. J. Isaacson.

Monday, November 11th.—"Steam," by Mr. H. Ade Clark, A.R.C.Sc., London.

Monday, November 25th.—"Development and Utilisation of Electric Power for Traction," by Mr. L. Wilson.

Monday, January 13th, 1902.—"The de Laval Steam Turbine," by Mr. Konrad Andersson.

Monday, March 10th, 1902.—"Wireless Telegraphy," by Mr. G. D. A. Parr, M.I.E.E.

Marriages.—On Saturday last, 12th inst., at St. Peter's, Limpsfield, Mr. Rollo Appleyard, A.M.Inst.C.E., son of S. Appleyard, Esq., of Herne Hill, was married to Miss Mabel Laming, daughter of the late Worthington Evans, Esq., of 47, York Terrace, N.W. The REVIEW cordially wishes Mr. and Mrs. Appleyard every happiness in their married life.

On October 2nd Mr. Frank Thomas (a partner in the firm of Mr. Bertram Thomas, Cornbrook Telegraph Works, Manchester), was married to Alice, daughter of Mr. Thomas Tyrer, of Forest Gate.

A Lesson in English Grammar. — With becoming diffidence we presume to defend ourselves from the strictures of a contemporary, which asks us to explain "how anyone could be *deprived* of that which he had not yet obtained." May we humbly suggest that the electrical Dr. Syntax should add to his school books the Imperial dictionary, and study the following definition of *deprive*, viz., "*to hinder from possessing or enjoying; to debar.*" Now, who is entitled to wear the fool's cap?

Personal.—Mr. Gibb, the managing director of the North Eastern Railway, is at present on a visit to America studying electrical traction, with a view to considering the question as to how far it could be utilised to improve the present train service.

Mr. Herbert de Grave, electrical clerk of works to the West Riding Asylums Committee, has resigned his position.

Mr. G. F. Preston, who was for several years a provincial superintendent of the National Telephone Company, has been appointed general manager of the London Post Office telephone service. Mr. A. M. Ogilvy, formerly the private secretary to the Postmaster-General, has been appointed the head of the telephone department.

The Newcastle Tramways Committee has appointed as manager of the new electric service Mr. A. E. Le Rossignol, at a salary of £750 a year. Mr. Rossignol was the resident engineer, and received the appointment out of 86 applicants.

The Postmaster-General has appointed Mr. J. W. Woods, superintending engineer of the South Midland District, and Mr. F. Harrison, assistant superintending engineer, London, to be superintending engineers, London, and Mr. G. W. Hook, assistant superintending engineer, London, to be superintending engineer of the South Midland district.

Mr. W. R. Wright, the Bootle Corporation electrical engineer, has secured an appointment at Wellington, N.Z., at £1,250 per annum. There have been 50 applications for the post he vacates at Bootle, the salary being £350.

Mr. M. Cochran, the electrical engineer and gas inspector to the Colombo Municipal Council, has retired. The Council is ascertaining from the Government through the Crown agents whether they can secure for the Council (*a*) the services of an officer competent to undertake the combined duties of electrical and gas adviser and city analyst, at a salary not exceeding R6,000, rising by biennial increments of R500 to R8,000, together with horse allowance of R480, and leave and pension in accordance with the rules of the Government service, or, failing this, (*b*) the services of an officer competent to undertake the combined duties of electrical and gas adviser only, on a salary not exceeding R4,500, rising by biennial increments of R500 to R7,500, with horse allowance, leave, and pension as above.

Mr. Walter Vaux, the manager of the Bradford Tramways and Omnibus Company, Limited, and Mrs. Vaux, have been presented with several pieces of silver and porcelain ware by the staff and company in recognition of the services which Mr. Vaux has rendered to the company during a connection with it extending over 19 years. The directors of the company also entertained Mr. Vaux to dinner prior to his leaving to take up his new post of manager of the South Lancashire Electric Tramways.

Mr. Isaac F. Cutler, who for over 10 years has been manager of the St. Helens and District Tramways Company, has resigned that position.

Dr. C. C. Garrard, having left the service of the Nernst Electric Light, Limited, has joined the staff of Messrs. Ferranti, Limited, of Hollinwood, as electro-chemist.

Mr. Crawford, of Dundee, has been appointed shift engineer at the Blackburn electricity works, and Mr. Watkins, of Newport, as switchboard attendant.

At the Wimbledon U.D. Council offices last Saturday evening Mr. S. C. Gibson, the chief assistant engineer at the electricity works, was presented with a spirit and smoking cabinet by his brother officials on leaving to take up the appointment of resident engineer to the Nuneaton electricity works. Mr. F. Barnes Spencer, chief electrical engineer, made the presentation. Mr. H. Tomlinson Lee, at present chief assistant engineer at Wakefield electricity works, has been selected out of over 100 applicants to fill the post vacated by Mr. Gibson.

The Blackpool Corporation recently appointed a sub-committee to endeavour to get Mr. R. C. Quin to continue as borough electrical engineer until March, 1903. After going into the matter, it has been arranged for him to leave in March next.

Mr. A. E. Blower has resigned his position as representative (for South Coast) of the Edison & Swan United E.L. Company, and has joined Mr. Ernest Roberts, of 6, Holborn Place, W.C. Messrs. Roberts & Blower have been appointed sole agents for South Coast and West of England for the Jandus arc lamp.

Faults in Boiler Brickwork.—A case is cited by the *American Electrician* of a test made to determine the effect of a faulty brick seating of a boiler 16 ft. by 5 ft. Settlement had cracked the brickwork, and the manager, with the false economy that so often distinguishes men who cannot see the effect of so-called trifles, had long refused to sanction repairs. At last a test was arranged, and was carried out upon the unrepaired plant, and the same after the repairs had been effected. The coal was measured, and the work done was, if anything, increased when the repairs had been made, while it was found that nearly three tons less coal was consumed, which represented over £2. The curious item is that the engineer was apparently unable to find a little clay to lute up the cracks at trifling expense. It has often been urged in these columns that not only should boiler brickwork be kept in good repair, but it may with advantage, if not faced with glazed bricks, be rendered impervious to air by a good coat of paint, or even by tarring it over. There can be no doubt that very large volumes of air find their way into boiler flues, not merely to the cooling of the boiler, but to the detriment of the draught and generally reduced efficiency. This leakage is the more certain to occur by reason that boiler brickwork is as dry and porous as it is possible for heat to make it, and that the mortar joints are often of a very crumbling nature. The ordinary man has very hazy ideas generally on mechanical or physical subjects, and does not realise that air passes freely through porous diaphragms; did he realise the fact, he might be equally impervious to the value of the cooling effects of such air. In fact, business men, so self-styled, will look calmly upon gross wastes of hundreds, or even thousands, annually, and will fret their souls away over an extra sixpence wages to a good fireman. Indeed, for a couple of shillings a week we have known a steam user to let his fireman leave, though the man was dealing with no less than 80 tons of coal per week. His duty was never afterwards performed with less than two men, who, however, justified their employment by burning more than their predecessor for the same output of works product.

The Institution of Electrical Engineers.—We are informed that the opening meeting of the session for the presentation of premiums and the presidential address will be on Thursday, November 21st, instead of on November 14th.

Gas Producer Plant.—In our article on the Daniels gas plant last week, we inadvertently said that one ton of coal produces about 1,600 cubic feet of gas. This should have been 160,000 cubic feet.

Electric Shunting Locomotives.—A 22-ton electric shunting locomotive is now employed on the sidings of the Lancashire and Yorkshire Railway, near Rochdale.

Appointments Vacant.—An assistant engineer at £100 per annum, is wanted for Epsom electricity works; a shift engineer is wanted for Bradford electricity works; and a superintending engineer for Hammersmith station.

Appointments.—The Southampton Electricity Committee is sending a deputation to Oldham, Halifax, London, and Tunbridge Wells to interview Messrs. S. W. Newington, H. F. Street, F. Aspinall (City of London Company), and Boot, who have been selected from 72 applicants as being likely men for the appointment of manager to the electricity works.

The Working Day in British Shops.—This question is discussed by Mr. T. A. Wheatley in *Cassier's Magazine*. He points out the many advantages of a two-break day and the better efficiency that is likely to accrue therefrom. Thus, the men enter the works or book time twice only per day instead of three times. There are fewer figures to add up. There are only two periods of restlessness per day in place of three; we refer to the time just before the bell rings, when even the best of men probably slack off their energies. Then, of course, there is the question of shop warmth and light and so on. Everything appears to point to the two-break day, and given power to remove a lot of railroad directors and put men of intelligence in their place, we see no reason why even in London a two-break day should not obtain. At present it is out of the question in London. The so-called working man would clash with the clerical and business element who already find trains overcrowded. Further, even granting this were overcome, the question of cheap tickets comes in. The workman would still have to come early into town and waste his time at the public house. As matters now are in London, it would seem better for men to come in early if only the employers could find a place for them to rest in and have their first meal. We know of an instance where the two-break day was attempted, but had to be abandoned solely because of the railway question. In country shops we see no reason why it should not be a success. We are by no means at one with Mr. Wheatley that the length of the present day must be maintained. We quite believe that it ought to be better utilised, but, we believe, had it not been for the output-restricting policy of the Amalgamated Society of Engineers and the beer habit of so many of its members, the trade of this country would probably long ago have justified an eight-hours' day. But between the sleepy employer and the lazy worker, the country has been laid open to an invasion of the foreigner, and the eight hours' day has been put off until master and man both become aware of their own folly. The present long hours of America are bound to be shortened when the American worker becomes alive to truths now hidden from him. The two-break day, we have been told, does not altogether suit American hours, for we believe quite a large proportion of the men take food with them into the works, and are by no means satisfied to go unfed until the mid-day meal.

The New Tunnel at Niagara.—The Canadian Niagara Power Company has awarded Anthony C. Douglass, of Niagara Falls, N.Y., the contract for the construction of the new power tunnel on the Canadian side of the river at Niagara. This tunnel is designed to aid in the development of the immense power of the Horse-shoe Fall. The tunnel will begin at a point at the head of Cedar Island and extend to the gorge of the lower river a short distance below the Horse-shoe Fall, where the water from the turbines to be installed in the big new wheel pit will be emptied into the river below the falls. In length this new tunnel will be about 2,200 ft., and its section will be somewhat larger than the section of the tunnel on the New York side, which is practically 21 ft. high and 18 ft. wide, the form being that of a horse-shoe. The Canadian tunnel will also be constructed in this shape, and, like the tunnel on the New York side, will be lined with brick throughout. It is interesting to compare the length of the Canadian tunnel with that of the tunnel on the New York side. As stated above, the Canadian tunnel will have a length of but 2,200 feet, while the tunnel now in use is over 7,000 ft. long. The single item of expense represented in this tunnel construction, goes to show that the development on the Canadian side will be much less in cost than was the extensive development on the New York side. For this reason the power in Canada will be less costly than the power on the American side. However, if it is the company's intention, as it probably is, to transmit the product of the Canadian turbines to adjoining cities, notably Toronto, the length of the necessary transmission line, as compared with that to Buffalo, may level up the general expense. The shaft necessary for the construction of the tunnel has been sunk. It is 185 ft. deep and 10 × 16 ft. in dimensions. This shaft is located at the head of Cedar Island, at the entrance to the Dufferin group, and it required 3½ months to sink it. In constructing the new tunnel it is likely that work will progress from the face of the cliff as well as from the bottom of the shaft, the gangs working towards each other. The contract provides for the completion of the tunnel by January 1st, 1903, which means that during the latter part of 1903 Niagara power will be available on the Canadian side in large quantities. The cost of the tunnel will be over half a million dollars.

Manchester Association of Engineers.—The members of this Association paid a visit on Saturday afternoon to the works of Messrs. Ferranti at Hollinwood, and also to the electricity generating station of the Manchester Corporation in Dickinson Street. In the evening a paper was read by Mr. Charles Day on "Engines for Driving Dynamos." He said that a few years ago a 500-H.P. engine and dynamo was considered large, but to day it was distinctly small, for about 30 electricity generating stations in Great Britain have engines of 1,000 H.P. and upwards.

Among the subjects to come before this Association during the session are the following:—

October 26th.—"American *v.* English Methods of Conducting Engineering Establishments," by Mr. E. Wood, Manchester.
November 23rd.—"Electric Welding," by Mr. T. T. Heaton, London.
January 11th, 1902.—President's Inaugural Address, by Mr. H. Hodgson.
February 8th.—"Applications of Portable Machine Tools," by Mr. J. A. Rowcliffe, Manchester.
March 8th.—Efficiencies of Electric Cranes," by Mr. R. Matthews, Manchester.

The meetings are held in the "Masonic Room," Grand Hotel, Aytoun Street, Manchester, at 7 p.m.

Electro-Pneumatic Signalling.—The North-Eastern Railway has given an order to Messrs. McKenzie & Holland for an installation of the Westinghouse electro-pneumatic system to be erected forthwith at Tyne Dock. *Transport* says that the plant, which is already in hand, will consist of two cabins, the larger of which will contain an electro-pneumatic locking frame of 71 levers, and the other one of 35 levers, making a total of 106 levers. It is estimated that, if the old style of mechanical locking had been adopted for these cabins, about 250 levers would have been required to control the points and signals of the yard at Tyne Dock.

NEW COMPANIES REGISTERED.

Pioneer Power Company of London, Limited (71,496).—This company was registered on October 2nd, with a capital of £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in plant and machinery used in the creation or application of any motive power, and in particular compressed and heated air, electricity and heated water, and in the application of the same to the haulage and propulsion of goods, trucks and passenger vehicles, to equip, maintain and work by such motive power any train or railway or other system of vehicular communication, and to carry on the business of tramway, omnibus and light and other railway proprietors, locomotive and trolley builders, manufacturers of accumulator vehicles, carriers of passengers and goods, &c. The first subscribers (each with one share) are:—Grey, 22, South Street, Park Lane, W., peer; C. R. Wilson, S.C.M.S., C.P., 21, Pont Street, S.W.; Kintore, 5, Portman Street, W., peer; C. S. Drummond, 39, Victoria Street, S.W., director of public companies; C. S. B. Hilton, Donington House, Norfolk Street, W., director of public companies; S. Lings, St. James's Square, Manchester, cotton spinner; and H. Phillips, 10, Henrietta Street, Cavendish Square, director of public companies. No initial public issue. The number of directors is not to be less than three nor more than nine; the subscribers are to appoint the first; qualification, £50; remuneration as fixed by the company.

Tramways Construction Company, Limited (71,547).—This company was registered on October 8th, with a capital of £1,000 in £1 shares, to carry on the business of contractors for the construction and equipment of tramways, light railways, and any

roads or ways to be used for traction by electricity, steam, horse, or other power, and for the construction and equipment of subways, bridges, electric lighting and other works, &c., and to work and carry on any tramways or light railways, either as owners or lessees or under contract. The first subscribers (each with one share) are:—A. P. Tabraham, Rosemorran, Kent Gardens, Ealing, W., gentleman; L. Edwardes, Little Roke, Henley, Surrey, gentleman; F. H. Morris, 18, Croftdown Road, Highgate Road, N.W., gentleman; H. J. Buttler, 20, Cottage Grove, Bow, E., gentleman; A. C. D. Collis, 111, Plashet Road, Upton Park, E., gentleman; E. D. Wright, The Nook, Cranbrook Gardens, Ilford, Essex, gentleman; and A. M. Kyd, Normandy House, 71, Cazenove Road, N., gentleman. No initial public issue. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

D. Hulett & Co., Limited (29,463).—The company's annual return was filed on July 31st, when 6,000 shares were taken up out of a nominal capital of £35,000 in 7,000 shares of £5 each. £5 per share has been called up on 1,900 shares, resulting in the receipt of £9,500; 4,100 shares are considered as fully paid. No mortgages or charges.

SUPPLY STATION ACCOUNTS.

Hampstead Borough Council Electricity Accounts.

During the last year the electricity works of the Hampstead Metropolitan Borough Council were considerably extended. The new engine room, one boiler house and chimney were finished, and another boiler house commenced. The result has been that for the first time in the history of the undertaking there is ample plant installed to meet all requirements. A start has been made in incandescent street lighting, and various improvements have been introduced in the existing arc lighting. A departure has also been sanctioned in the method of laying the mains, cables laid on the solid system being adopted as the standard in lieu of armoured cables laid directly in the subsoil. The growth of the undertaking during the past year is evidenced by the quarterly returns:—

Year 1900.	First quarter.	Second quarter.	Third quarter.	Fourth quarter.
Consumers ...	1,770	1,864	1,980	2,060
Lamps connected	110,658	115,892	121,465	125,892
Units sold ...	257,387	268,095	660,417	573,248

General Statement.

	1899.	1900.	Increase.
Total capital expenditure ...	£162,212	**£236,544**	£74,332
Number of units sold	1,418,442	**1,759,147**	340,705
Total maximum load in kw. ...	1,198	**1,506**	308
Number of lamps connected ...	104,579	**125,892**	21,313
Gross revenue	£30,660	**£31,812**	£1,152
Gross expenditure...	£14,336	**£20,538**	£6,202
Gross profit	£16,324	**£11,274**	−£5,050
Average price per unit sold ...	4·98d.	**4·15d.**	−·83d.

Hampstead has always been a district in which the revenue per lamp has been low. The units sold have slightly increased, and now stand at 15 units per annum per lamp connected. The reduction in prices charged made in 1898 has caused the revenue to fall from 5·14d. to 4·27d. per unit sold to private consumers, and the gross revenue from this source has, accordingly, only increased by £632. On the whole output the return is now just over 4¼d. per unit, being a reduction of more than ⅝d.

Revenue Statement.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£29,429	4·98d.	**£30,400**	4·15d.	−·83d.
Meter rents	1,109	·19d.	**1,402**	·19d.	·00d.
Sale of lamps, &c.	—	—	—	—	—
Sundry fees, &c.	122	·02d.	**10**	·00d.	−·02d.
Gross revenue ...	£30,660	5·19d.	**£31,812**	4·34d.	−·85d.

For last year the works costs come out at over 2½d. per unit against 2d. in the preceding year. Most of this is accounted for by the coal bill, which took £4,095 more, and the rest is principally distribution charges; 8,606 tons of coal were consumed, costing £11,300, whereas in 1899 the quantity was 6,949 tons, absorbing £7,335. Wages are always greater when a station has to be run and maintained concurrently with building operations, while repairs to mains and meters have become necessary. Although not materially affecting last year's figures, the new assessment of the works and mains must tell against the accounts next published, as the burden of rates and taxes will be made on a much higher value than formerly.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal	£7,357	1·25d.	£11,542	**1·56d.**	+·31d.
Oil, waste, water, and engine room stores.	856	·14d.	936	**·13d.**	−·01d.
Salaries and wages incurred in generation and distribution.	1,898	·32d.	2,542	**·35d.**	+·03d.
Repairs and maintenance of engine, boilers, dynamos, buildings, and street lamps.	1,721	·29d.	2,452	**·33d.**	+·04d.
Works costs	£11,832	2·00d.	£17,382	**2·37d.**	+·37d.
Rent, rates and taxes ..	381	·07d.	406	**·05d.**	−·02d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	1,308	·22d.	1,588	**·22d.**	·00d.
General establishment charges, stationery and printing, law charges and insurance	711	·12d.	797	**·11d.**	−·01d.
Other expenses: certification of meters	104	·02d.	365	**·05d.**	+·03d.
Total costs ...	£14,336	2·43d.	£20,538	**2·80d.**	+·37d.

The reduction in revenue, coupled with enhanced costs, has caused the gross profit to fall by £5,050, while the financial charges have run up by £2,290. This difference, amounting to £7,340, has caused the net profits to be reduced to £2,017, which sum has been placed to the credit of the reserve account. Taking the whole of the facts into consideration, it must be admitted that the results are by no means unsatisfactory, and Mr. G. H. Cottam, the borough electrical engineer, must be pleased that they come out as well as they do.

Profit Statement.

	1899.	1900.
Interest on loans	£4,071	£6,351
Sinking fund for repayments	2,896	2,906
Net profit carried to reserve and depreciation funds	8,266	2,017
" " deficits on loans	873	—
" " expenditure on arc lighting works	218	—
" " forward	—	—
Gross profit	£16,324	£11,274

Ayr Corporation Electricity Accounts.

The accounts of the Ayr municipal electricity undertaking show a retrograde movement during last year. In 1897 the deficit was £1,155, the next year this figure had fallen to £747, and in 1899 it amounted to only £696, but last year it ran up again to £1,127. From the General Statement it will be seen that the extensions were rather larger than in recent years, but the increase in output is only half that recorded for 1899.

General Statement.

	1899.	1900.	Inc.
Total capital expenditure ...	£46,865	**£56,158**	£9,293
Number of units sold	425,639	**490,496**	64,857
No. of lamps connected.. ...	17,912	—	—
Maximum load in kw.	256	**282**	26
Gross revenue	£5,245	**£5,591**	£346
Gross expenditure...	£3,480	**£4,158**	£678
Gross profit	£1,765	**£1,433**	−£332
Average price per unit sold ...	2·85d.	**2·64d.**	−·21d.

The gross receipts have increased only about 7 per cent., and still stand below £5,600. The effect of the scale of charges adopted has been to further reduce the revenue from the sale of energy by just over ⅛d., the figure of 2⅜d. received from this source being extremely moderate and explaining the inability to make ends meet, although a larger demand might be expected when the rates are so low. Of the total of 490,496 units, private consumers took 170,736 only, while the public lamps (85 arc and 146 incandescents) consumed no less than 319,760 units.

Revenue Statement.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£5,056	2·85d.	**£5,392**	2·64d.	−·21d.
Meter rents	16	·01d.	**20**	·01d.	·00d.
Sale of old material	173	·10d.	**179**	·09d.	−·01d.
Sundry rents, &c.	—	—	—	—	—
Gross revenue ...	£5,245	2·96d.	**£5,591**	2·74d.	−·22d.

The item of coal has increased in the last three years: thus it was ·68d. in 1897 and in 1898, in 1899 it reached ·72d. and is now ·98d. Mr. A. J. Fuller, the burgh electrical engineer, must be complimented on having practically wiped out this increase by reducing his gross bills for oil, waste, &c., wages, salaries and establishment charges; these economies leaving only an increase of under $\frac{1}{10}$d. to bring the total cost just over 2d. per unit.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal and unloading same ..	£1,288	·72d.	£1,994	**·98d.**	+·26d.
Oil, waste, water and engine room stores.	83	·05d.	74	**·03d.**	−·02d.
Salaries and wages incurred in generation and distribution, and attending street lamps.	974	·55d.	887	**·43d.**	−·12d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	265	·15d.	281	**·14d.**	−·01d.
Works costs ...	£2,610	1·47d.	£3,236	**1·58d.**	+·11d.
Rent, rates and taxes ..	146	·08d.	229	**·11d.**	+·03d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	417	·24d.	410	**·20d.**	−·04d.
Establishment charges, stationery and printing, law charges and insurance	262	·15d.	237	**·12d.**	−·03d.
Other expenses, repairs to property.	45	·02d.	46	**·02d.**	·00d.
Total costs ...	£3,480	1·96d.	£4,158	**2·03d.**	+·07d.

As the gross expenditure increased by £678, but revenue by only £346, the profit was less in 1900 as compared with 1899 by £332. The financial charges absorbed £99 more, making an additional loss of £431, which has to be added to the former deficit of £696, thus accounting for the net loss of £1,127 in 1900. The public lighting must be debited with most of this loss, as it takes nearly twice as many units as private consumers and brings in less than two thirds of the revenue they yield.

Profit Statement.

	1899.	1900.
Interest on loans	£1,531	£1,509
Sinking fund for repayments	930	1,051
Net profit carried to rates	−696	−1,127
Gross profit	£1,765	£1,433

St. Pancras Electricity Accounts.

The accounts of the St. Pancras Borough Council show that the influences generally characterising the working of last year have had acute effect in the metropolis. Thus the increase in gross revenue is exceeded by the increase in gross expenditure, resulting in a diminished gross profit, and consequently in a smaller net profit. The revenue per unit last year was less than previously, but each unit cost more to produce. The capital expenditure as given for 1899 has been corrected for expenditure chargeable to other funds than the electric supply account. The growth of the undertaking is shown by a statement attached to the accounts, of which the following contains the first two and last three lines:—

Year.	Number of consumers.	Energy sold to private consumers at 3d. per unit.	Energy sold to private consumers at 4d., 5d. and 6d. per unit.	Number of lamps applied for. Incandescent 16-c.p.	Arc.	Motors.
1892 ...	172	—	£8,167 ...	9,900	82	11
1893 ...	238	£385	9,161 ...	12,851	110	19
1898 ...	984	8,415	23,446 ...	38,124	292	91
1899 ...	1,184	11,700 at 2d. & 3d. per unit.	25,993 ...	46,172	315	126
1900 ...	1,438	£12,564	25,914 ...	57,456	426	152

The general position of the undertaking is shown by the

General Statement.

	1899.	1900.	Inc.
Total capital expenditure ...	£286,546	**£336,795**	£50,249
Number of units sold	2,477,508	**3,008,481**	530,973
Maximum load in kilowatts ...	1,789	**2,275**	486
Gross revenue	£45,063	**£49,215**	£4,149
Gross expenditure	£27,416	**£33,705**	£6,289
Gross profit	£17,650	**£15,510**	−£2,140
Average price per unit sold ...	4·29d.	**3·846d.**	−·444d.

Public lighting has been increased by 193 arc lamps, equal to 87 per cent., which swelled the receipts by £3,207. The small increase from private supply is accounted for by the reductions in the rates made in June, 1900, and whereas 4·48d. was the average obtained in the first half of that year, the figure fell to 3·63d. for the last six-monthly period. The total reduction is nearly ½d. per unit, bringing the average below 4d.

Revenue Statement.

	1899. Gross	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Sale of energy	£44,332	4·29d.	**£48,211**	3·846d.	−·444d.
Meter rents	98	·01d.	**134**	·011d.	+·001d.
Sale of materials and work done	628	·06d.	**580**	·046d.	−·014d.
Sundry rents, fees, &c.	8	·00d.	**290**	·023d.	+·023d.
Gross revenue ...	£45,066	4·36d.	**£49,215**	3·926d.	−·434d.

In the costs, coal and oil have gone up by ·17d., and repairs and wages are reduced by nearly ·10d., which leave the works costs increased by something rather less than $\frac{1}{10}$d. Further economies in salaries and establishment charges have almost wiped out the increases, with the final result that the total cost is only slightly higher than in 1899. The average increase in the price of coal was 3s. 3d. per ton, and as the total consumption was 12,026 tons, this represented a money value of £1,954. Special charges for alterations in the Regent's Park station accounted for £945; the re-erecting of plant and transference of boilers to King's Road station being charged against the revenue account.

Cost of Production.

	1899. Gross.	1899. Per unit.	1900. Gross.	1900. Per unit.	Inc.
Coal..	£9,499	·92d.	£13,343	**1·065d.**	+·145d.
Oil, waste, water, carbons and engine room stores	1,238	·12d.	1,817	**·145d.**	+·025d.
Salaries and wages incurred in generation and distribution, and attending public lamps	5,102	·50d.	5,982	**·477d.**	−·023d.
Repairs and maintenance of buildings, engines, boilers, dynamos, and renewals	7,135	·69d.	6,846	**·546d.**	−·069d.
street lamps			945	**·075d.**	
Works cost ...	£22,974	2·23d.	£28,933	**2·308d.**	+·078d.
Rent, rates and taxes ..	1,337	·13d.	1,597	**·128d.**	−·002d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	1,720	·17d.	1,808	**·144d.**	−·026d.
General establishment charges, stationery and printing, law charges and insurance.	885	·08d.	915	**·073d.**	−·007d.
Other expenses: work changed for & compensation	500	·05d.	452	**·036d.**	−·014d.
Total cost ...	£27,416	2·66d.	£33,705	**2·689d.**	+·029d.

The gross profit was less by £2,140 than in 1899, which, with an increase in financial charges of £1,893, meant a reduction in the net profit of £4,033, and therefore we find the former surplus of £6,955 has come down to £2,922.

Profit Statement.

	1899.	1900.
Interest on loans, deposits and overdraft	£7,321	£8,648
Sinking fund for repayments	3,374	3,940
Net profit carried forward	6,955	2,922
Gross profit	£17,650	£15,510

CITY NOTES.

Hiram Maxim Lamp Company, Limited.

At the meeting held on Wednesday at the offices, 17, Shaftesbury Avenue, W., the following report was submitted by the directors:—

The total number of shares issued and allotted is 60,000, of which 45,000 were allotted as fully paid, 37,500 in satisfaction of the purchase price of the concession from the Sir Hiram Maxim Electrical and Engineering Company, Limited, 7,500 in connection with the subscription of working capital, and upon the remaining 15,000 shares the sum of 10s. has been called and paid up in cash. The total amount of cash received by the company on capital account in respect of the shares issued wholly for cash is £7,500. The preliminary expenses of the company are as follows:—

	£	s	d
Fees and deed stamps	£23	2	
Stamp duty on capital	175	0	0
	£198	2	6

In moving the adoption of the directors' report, Mr. Henry Wardlaw, the chairman, said the Companies' Act, 1900, required that every company registered since January 1st last should hold its statutory meeting within three months from the date at which it was entitled to commence business. He might inform them that the term "commence business" was not an unimportant epoch in connection with a new company, as the directors had to satisfy the Registrar of Joint Stock Companies before he would issue his certificate entitling the company to commence business, that they had fully complied with all the requirements of the Companies' Acts, and the issue of that certificate was evidence that that had been satisfactorily done. Their certificate was dated July 27th last, so they would see no time was lost after the company went to allotment in putting itself in a position to

commence operations. The shareholders had all received a copy of the report of the directors and auditors, which had been prepared to supply the information required by Section 10 of the new Act. They had seen from the report that the whole of the working capital of the company had been fully subscribed and allotted, and he was pleased to be able to inform them that there was not a single defaulter among the list of shareholders, and the whole amount entitled to be paid had been duly paid into the company's bankers. It would be observed that the company had incurred no extraordinary expenses, but had merely paid the stamp duties on its capital and deed stamps on registration and other such fees, amounting together to the sum of £198 2s 6d., which left the company, with its working capital, practically intact. The concession referred to in the prospectus was duly vested in the company, and they were in the position foreshadowed in the prospectus; the organisation and business of the company being now on a sound basis. They had the sole right and monopoly all over the world for the sale of the Maxim lamps. He thought, to many of them at least, it would be unnecessary for him to emphasise the intrinsic merits of the lamp which was the invention of that well-known and successful inventor, Sir Hiram Maxim, whose name alone imparted to it the hall mark. The factory belonging to the Sir Hiram Maxim Electrical Corporation who manufactured those lamps was, the directors thought, even when that company agreed to take the concession, to be in a most thoroughly and perfectly equipped condition, but that corporation, wishing there should be no possible obstacle in the way of delivering a thoroughly perfect article, had since spent some thousands of pounds in further equipment to anticipate an early increase of that company's sales over the number contemplated by the prospectus. They had, moreover, on the suggestion of the manager of that company, made an improvement in the style of the lamp itself, and they believed that with those new improvements the articles they would supply would be second to none. Electric lighting was still on the increase both at home and in our Colonies, and further expansion was certain, and necessarily there must be a daily growing demand for the incandescent electric lamps. There were several lamps on the market at the present time, and it was not his place to criticise their merits and defects. Some of those lamps enjoyed a high reputation, but they had the advantage of being the last in the field, and consequently had had the opportunity of considering all those merits and defects in conjunction with the new processes of Sir Hiram Maxim, and had been enabled thereby to produce what they believed to be a perfected article. They should approach the sphere of competition at least with confidence. They did not aspire to the monopoly of the trade, even of this country, in incandescent lamps. They could not possibly meet the demands even had they orders to do so, and he felt they would quite have their work cut out to meet the daily requirements of the trade, increasing as it was in all directions. It would obviously not be wise of him to go into details at that meeting as to the methods which the board adopted for conducting the business, but he might say that arrangements had been made, and were in course of negotiation, for the company to be represented in the most influential centres, and that important agencies were being established in the Colonies, from which the company expected to receive large business. Arrangements had been made for taking over the lease of showrooms which were situate in a central position, and branch establishments would be opened also in important towns of the provinces, but the policy of the directors at the present time was to keep down the outgoings of the company to the lowest possible point, so economising and making the working capital available for more extensive operations in connection with the sales. They would be pleased to hear that the company was daily receiving sample orders from most large users of electric lamps, who were naturally desirous of testing the lamps against others, and they were not afraid of the result, and of their orders following, and they looked forward to have reached, if not exceeded, at the end of the first trading year, the estimate of sales mentioned in the prospectus. Concluding, he said he trusted the directors would have the pleasure of meeting them on the next occasion with a prosperous balance-sheet, and from the outlook of things he did not think he was too sanguine in foreshadowing the payment of an interim dividend.

Carl V. de Falbe seconded the motion, and the report was unanimously adopted.

Brockie-Pell Arc Lamp, Limited.

The second ordinary general meeting of the shareholders of this company was held on Tuesday at the premises, 60, Worship Street, Finsbury, the Right Hon. Lord Suffield presiding.

The Chairman said that he was sorry to see so few shareholders present, as he had hoped to have seen a larger gathering to hear the glad news concerning their company, for although they might not be in a position to give a dividend, they could show that they stood in a very satisfactory position. The report and accounts which they presented that day proved that the scheme of reconstruction proposed by the directors, and so loyally supported by the shareholders, had borne fruit. The result of the year's trading, after writing off £534 for depreciation, had been a net profit of £2,465, which would allow a sum sufficient to pay a dividend of at least 2½ per cent., and to carry forward a respectable balance. The directors would have very much liked to have recommended the payment of a dividend, but they felt that in the interests of the company it was wise that the profits be kept in hand for the development of the business and to enable them to meet the increasing demand for the company's manufactures. During the year under review the orders had steadily increased, both in number and in value, so that the turnover was nearly 25 per cent. in excess of the period covered by the last balance-sheet. Many new customers had been placed upon the books, whilst repeat orders from old friends showed that the Brockie-Pell lamp was fully maintaining its reputation. Amongst the larger contracts entered into might be mentioned the supply of 800 lamps for the lighting of the streets and squares of Westminster, 200 lamps for Poplar, 200 lamps for the tramways at Newcastle, 115 lamps for the Brighton tramways, besides many other smaller orders. There were other contracts in hand which were now being completed. At the present time 1,000 lamps were in course of construction at the company's works, over 800 of which were for orders already received in the first quarter of the new year. In connection with one of the contracts, he might tell them that the consulting engineer, who was well known as a leading man in the electrical world, stated that the Brockie-Pell lamps, though rather more expensive, were, in his opinion, the best lamps in the market, as the cost of maintenance was so small in comparison with others. In addition to the other contracts, the company had supplied 1,100 lamps for the lighting of the Glasgow Exhibition. They knew that those lamps had given perfect satisfaction, and they had hoped to have had a certificate to that effect before the meeting. As regarded the present year the orders received during the quarter ending September 30th last were over 50 per cent. in excess of those received during the same period last year. He said that he felt it was only right and fair that he should reiterate for the information of the shareholders that in Mr. Fitzgibbon the directors had found a thoroughly able and energetic successor to Mr. Shrimpton, and the board could not speak too highly in praise of Mr. Fitzgibbon's work. There had been many difficulties to overcome, and he considered that the company owed its present satisfactory condition in a large measure to the work of Mr. Fitzgibbon, their manager. His Lordship concluded by proposing the adoption of the report.

Sir F. D. Dixon-Hartland, Bart., M.P., in seconding the resolution, said that the trading account in the new company was not shown, as the auditors did not consider it a good plan that the company should print all its figures for the information of possible competitors. He would like to give them a few figures showing the progress of the company from its commencement. The first report they issued showed that they sold £10,000 worth of lamps, the gross profit was £2,000, the establishment charges £7,700, and their loss £4,590. In the second report they sold £17,467 of lamps, showing a gross profit of £4,192; the establishment charges were £6,885, and there was a loss of £1,496. In the third year their sales amounted to £19,224, the gross profit to £6,803, the establishment charges to £6,846, or a profit of £439, instead of a deficiency of £4,590 for the first year. Coming to the first year of the new company, their sales had totalled £24,564; the gross profit was £9,174; the establishment charges £7,122, giving them a net profit of £2,465. He thought that would show that they were making substantial progress, and that the lamp was becoming more and more appreciated. Personally, he had no hesitation in saying that if they had sufficient capital to work the company, they had turned the corner, and they would now become a dividend-paying concern. They could have paid a dividend this time, but they thought it better to carry the whole of the profits forward. With regard to the lighting of the Glasgow Exhibition, on all hands they had heard nothing but praise as to the way in which the lamps had acted. They had never broken down the whole time, and everybody who had visited the Exhibition had been pleased with the excellent light, and the directors hoped it would lead to their getting contracts for lighting other exhibitions. Having explained how the £11,285 new capital had been expended, the speaker said that they wanted the further call to carry out the contracts they had got. He might tell them that they had been so close with regard to their cash, that on more than one occasion Lord Suffield and himself had guaranteed the bankers personally to make advances on purpose that the company should be saved any difficulties. As they knew, that was not part of the directors' duties; but they had gone out of their way to do that which showed that they had great faith in the company. When they got the calls in they would be able to pay off all the loans from the bankers instead of having to pay interest.

Some discussion ensued, and, replying thereto, Sir F. Dixon-Hartland said that they had not taken any profit whatever in regard to the Glasgow Exhibition lamps in the present balance-sheet. The lamps were simply taken in stock at cost price, and therefore any profit that arose would go into the next year's account. With respect to the call, it was plain that the directors needed the money, but there was no reason why they should not consider the question of an interim dividend being paid at the end of the half-year if they found that the profits would admit of it.

The report was then adopted.

Consolidated Telephone Construction and Manufacturing Company.

The directors' report reads as follows:

Your directors beg to submit the report and accounts for the year ending March 31st, 1901. The results for the period comprised in the accounts have been adversely affected by a flood which took place at the Coventry work during January last. A considerable quantity of goods ready for delivery were damaged. The business of Williamson & Joseph, Limited, was acquired by your directors as stated at the last general meeting. The directors are satisfied with this purchase and believe it will add materially to the profit-earning capaci y of the company. The trading profit for the year amounts to £2,832 10s. 1d.; to this sum should be added the portion of the profit of Williamson & Joseph Limited, in form of dividend, amounting to £366 18s. 9d.

These two figures give a total trading profit of £3,199 8s. 10d., which compares favourably with the figures of previous years, viz:—

Year ending March 31st, 1898	..	..	..	..	£92	13	0
" " " 1899	..	..	..	..	784	0	1
" " " 1900	..	..	..	..	1,192	0	9
" " " 1901	..	..	..	..	3,199	3	10

The total income for the year on revenue account amounts to £5,430 9s. 6d., as compared with £3,780 8s. 9d. for the previous year. Deducting expenses amounting to £2,956 12s. 11d., and adding the amount brought forward from last year, there remains an available balance of £5,641 16s. The interim dividend at the rate of 3 rer cent. per annum for the first half of the year amounted to £1,602 1s. 2d, leaving a balance of £4,039 14s. 10d., out of which the directors propose to pay a dividend for the last half of the year at the rate of 3 per cent. per annum, less income-tax, making a total distribution for the year of 3 per cent., and leaving the sum of £2,451 14s. 9d. to be carried forward to next account. Your directors have devoted a great amount of time and attention to the improvement of one of the principal assets of the company, which consists of shares and debentures in the Anglo-Portuguese Telephone Company. Long and important negotiations with the Portuguese Government have recently resulted in the granting of a new concession which extends the period of the monopoly to 1937 (the old concession would have terminated in 1917). There are many changes in the terms of this concession, which secure important advantages to the company. The directors look to increased profits accruing to the Consolidated Company from this source in the near future. The lawsuit initiated by the Edison-Gower-Bell Telephone Company against infringers in Belgium has made progress, but the directors regret they are still unable to report that it has been finally disposed of. Mr. C. H. Reynolds, C.I.E., has been elected general manager to the Pacific Cable Board. This post precludes him retaining his position as a director of your company, and he has consequently tendered his resignation, which the board has accepted with regret. The directors with a view to securing the best interests of the company, have, in accordance with the Articles, appointed Mr. John L. Newland in his place. Mr. Newland has been identified with the company during the last two years as manager. Mr. H. F. Jackson is the retiring director, and being eligible, offers himself for re-election. The auditor, Mr. J. G. Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths & Co.) retires, and being eligible, offers himself for re-election.

Mr. H. F. Jackson presided at the annual general meeting of this company held at Winchester House on Tuesday. In moving the adoption of the report, he said that the report was more satisfactory than the company had been able to show for some little time. The trading profit showed a considerable improvement on that of the last three or four years. The figures were not altogether satisfactory; they ought to have been a great deal better, but they showed, at any rate, that they had turned the corner, and that the hopes which the new board had when they were elected had to some extent been justified. Had it not been for a flood at the Coventry works, the trading profit would have been considerably better. At the last meeting he indicated that the board were thinking of purchasing a business so as to extend the field of the Consolidated Company. The business was that of Messrs. Williamson & Joseph. The balance-sheet showed that the Consolidated held £7,700 in debentures of W. & J. After careful investigation they found that the assets which they were going to acquire might roughly be put down as worth £15,000. The book debts, £2,500, had since been collected, the stock was worth £4,500, and the premises, plant, machinery, fixtures, &c., between £5,000 and £6,000. The book debts and stock alone were very nearly equal to the amount of cash paid for the business. They thought that the connection of W. & J. with the Consolidated would be a great advantage to it. After quoting from the report (see above) the figures relating to income and expenses, the chairman said that the trading profit from the Coventry department was £2,832, and the dividend on the Williamson & Joseph shares, for which they paid nothing, was £367, making a total of £3,199. The principal change in that portion of the accounts lay in the elimination of dividends from the National Telephone Company and the United River Plate Co. The former shares they sold at just under par, and the price of £5 shares had since been as low as £3. Those two investments were sold, and provided the money invested in W. & J. The £7,700 in the balance-sheet against W. & J. debentures would be reduced to £5,700 very shortly, as £2,000 would be put into the concern by friends of the present manager. That was always contemplated, but owing to legal difficulties they were only just about to get the money. The shares and debentures in the Anglo-Portuguese Telephone Company formed one of the principal assets. The capital of the company was £50,000 issued out of £75,000 authorised, and out of that the Consolidated practically holds £37,500. The directors found when they originally took office that that asset was not in a very satisfactory condition. The concession was to terminate in 1917, and owing to the very inferior service which had been given there was some chance of the concession being forfeited. The managing director went out to Lisbon several times, with the result that he had been able to obtain from the Portuguese Government an extension of the concession by 20 years, and the importation of material without payment of any duty (formerly 40 or 50 per cent. *ad val.* was payable). A reorganised tariff, favourable to the company, was also arranged. The great improvements required, if the service was to be brought up to date, would necessitate the expenditure of a considerable amount of capital, and the directors could not see their way clear to financing the Anglo-Portuguese Company without the improvement in the terms of the concession. The Edison-Gower-Bell litigation, which had been unsettled for the past 10 years, would, they hoped, result in something satisfactory to the Consolidated by the next meeting. In regard to the item shown for stock of instruments and materials, this last year stood at £6,863. This year it had risen to £11,075. The great portion of the increase was in raw goods, owing to the determination of the directors to extend the company's field of operations beyond Government department and railway companies work, so as to deal with the general trade in telephone apparatus. This necessitated a very much larger stock, and he thought that that figure was likely to increase rather than decrease. They had found that having the works at Coventry was a very great disadvantage. They were the only works of the same class in Coventry, and that made it very difficult to obtain labour of the best class and in proper quantity. They were now considering the advisability of removing a very large portion of the works from Coventry to the neighbourhood of London. If they did that a certain amount of outlay would be incurred, but it was sure to have good results.

Shareholders asked questions as to the prospects of interim dividend for the next year; as to the business of Williamson and Joseph; as to whether the stocks was valued by an independent valuer or the company's manager; as to the progress of the telautograph; and in reply

The Chairman said in regard to interim dividend there were expenses ahead for moving to London, which made the board wish to keep in hand as much cash as possible. That was the best for the shareholders in the long run, but they hoped that the result of the present financial year would be the payment of a dividend at the rate of 3 per cent. They wanted to get on a proper basis before increasing the dividend. In regard to the amount of stock, that was valued by the works manager. It was made up of thousands of items, and they would not easily find an outside valuer who would have more satisfactory information than their own works manager. The company had always dealt with the stock in that manner, and saw no reason to depart from that custom. For the telautograph they had received an order from the Telautograph Company amounting to between £1,300 and £1,400, and it was nearly completed.

After further brief discussion as to the stock valuation, the Chairman said that the board would consider, prior to next stock-taking, whether they could find it practical to call in an outside valuer.

Mr. F. W. Kerr, managing director, seconded the motion, which was carried unanimously.

The retiring directors and auditors having been re-elected, the meeting closed with a vote of thanks to the chairman and directors.

Cape Electric Tramways Co.

Colonel Sir Charles Euan Smith presided on Wednesday at Winchester House, E.C., over the fifth ordinary general meeting of the shareholders of the above company, and, in moving the adoption of the report, said the board of directors had again the pleasure of congratulating them on the very satisfactory results of last year's working. The war, which indirectly had affected them somewhat prejudicially in the direction of delaying the erection of their new works and the landing of their rolling stock, &c., had so far had no adverse influence upon the receipts of the company. The progress made was not only very substantial, but also of a very progressive character. They had carried over 2,000,000 more passengers that year than in the preceding year, and their net profits, after providing for payment of debenture interest, aggregated the total sum of £75,922 2s. 9d., against a profit for the year 1900 of £65,204 4s. 5d. To the former sum £11,319 11s. 2d., the balance from the previous year had to be added, so that £87,241 13s. 11d. represented the figure at the disposal of the directors for the payment of dividends and the provision of the necessary reserves. From that amount two dividends, one amounting to £24,000, was paid on February 1st, 1901, and one amounting to £26,400 was paid in August, 1901, which included, of course, the dividend on the new shares. Altogether the dividends amounted to 12 per cent. They had determined to carry £20,000 to the reserve fund, leaving a balance of £16,841 13s. 11d. to be carried forward to next year's accounts, from which, however, the necessary provision had to be made for the payment of directors' and auditors' fees. This result, if they regarded it in the light of all the circumstances which covered their operations in Cape Town and Port Elizabeth, whether as regarded the incidence of the plague or the prolongation of the war, could not fail to be regarded as of a highly satisfactory character. The report explained the extensions which had been completed, and which had been sanctioned, but it was necessary to qualify one paragraph, which dealt with the extension to the Dock Gates. It appeared from information they had received by the last mail, that although formal sanction for the Dock Gate extensions had been given, the final instructions to their officials for immediately proceeding with the work were being withheld by the municipal authorities until certain matters now in process of negotiation had reached a satisfactory solution. They did not anticipate, however, that the final order would be delayed very long, especially as the chairman of the local board was now on his way to the Cape, and was in full possession of the views of the board, and hoped to remove all difficulties. The delay in the erection of a large amount of new machinery and plant and rolling stock had had the serious effect of overcrowding all their cars at Cape Town, which had produced a natural expression of public discontent. The board was doing all in its power to remedy the evil, and when the works now in progress were finished, and the rolling stock now in transit was placed upon the roads, this cause of discontent would disappear. As regarded the appeal which the Eastern Telegraph Company had lodged in the Privy Council against the verdict of the Supreme Court in Cape Colony in the Cape Tramways Company's favour, he had nothing further to tell them, as the law was proverbially long. In conclusion, he might tell them that the board had determined on the immediate distribution of a 4 per cent. interim dividend for the current year. In announcing that dividend within three months of the end of the financial year, he would give a word of warning to the shareholders not to look upon that as a regular quarterly payment. They had found themselves in a position to pay it, but they would do wrong to encourage the belief that the company would in the immediate future find itself in a position to maintain that high rate of interest.

Mr. J. B. Taylor seconded the motion.

Mr. Blundell commented on the report as one who was familiar

with Cape Town, said the company ought to do 10 times as well when the extension from Port Elizabeth to the sea was made, and as to the Sea Point Railway which they had purchased, it should bring them in shoals of money at certain times of the day.

The report was adopted, and £1,500 was voted to the directors.

Cuba Submarine Telegraph Company.

The directors' report for the half-year ending June 30th, 1901, to be presented at the meeting to be held on October 23rd, reads as follows:—

The directors beg to submit, duly audited, the balance-sheet and accounts for the half-year ended June 30th last. The total receipts of the six months were £12,007 14s. 11d., while the expenses amounted to £5,519 2s., leaving a balance of £6,488 12s. 11d., to which has to be added £4,472 9s. 2d. brought forward from last account, giving a total of £10,961 2s. 1d. to be dealt with. The dividend on the preference shares will absorb £3,000 and leave £7,961 2s. 1d., out of which the directors recommend the payment of a dividend at the rate of 4 per cent. per annum on the ordinary shares, free of income-tax; the balance £4,761 2s. 1d. being carried forward to the current half-year. The cables have continued in good working order throughout the half-year, but the Manzanillo-Santiago section has since broken down and arrangements are now being made for its repair. This interruption does not affect the traffic. The directors regret that no reply has yet been received from the Government of the United States regarding the payment of the subsidy of £2,000 per annum in respect of the coast cables, now in arrear since January, 1899; of for the claim for damage done to the cables during the Spanish-American War, which it is hoped may be brought before Congress when it next meets. The retiring director is Mr. George Keith, who, being eligible, offers himself for re-election. Messrs. Gane, Jackson, Jefferys and Wells, C.A., the auditors, also retire, and offer themselves for re-election.

Western Telegraph Company.—The directors, after transferring £35,000 to the general reserve fund, and £2,000 to the maintenance ships' reserve fund, recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30th, 1901, and also the payment of a bonus of 2s. per share. The balance of the account is carried forward. The register of transfers will be closed from October 22nd to 30th.

Hampstead Electric Supply Company, Limited.—It is stated that notices have been issued convening an extraordinary general meeting of this company, to be held on the 21st inst., for the purpose of considering a scheme for the winding-up and reconstruction of the company.

City of London Electric Lighting Company, Limited.—The directors have made a private issue of £100,000 4½ per cent. second debenture stock. The preference and ordinary shareholders of the company were offered the stock at par, the directors taking up, on the same terms, any stock not applied for by the shareholders.

Indo-European Telegraph Company.—The interim dividend for the half-year ended June 30th is at the rate of 5 per cent. per annum, payable on and after November 1st. Transfer books will be closed from October 16th to 31st.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending Oct. 11th were £510; corresponding week last year, £460: increase, £50. Total to date, £20,664, corresponding period last year, £18,493; increase, £2,171. Miles of track open, 8¾.

Blackpool and Fleetwood Tramways.—The receipts for the week ending October 12th were £328; corresponding week last year, £334; decrease, £6. Total receipts to date, £18,869; corresponding period last year, £18,405; increase, £464.

Bristol Tramways and Carriage Company.—The receipts for the week ending October 11th were £3,850; corresponding period last year, £3,329; increase, £521.

Central London Railway.—The receipts for the week ending October 12th were £6,291; corresponding week last year, £5,421; increase, £870. Total receipts from July 1st (15 weeks), £86,435. Miles open, 6.

City and South London Railway.—The receipts for the week ending October 13th were £2,061; corresponding week last year, £1,647; increase, £414. Total from July 1st to date, £28,300; corresponding period last year, £22,884; increase, £5,416. Miles open, 4¾.

Dover Corporation Tramways.—The receipts for the week ending October 12th were £222 5s. 3d.; corresponding week last year, £218 17s. 10½d.; increase, £3 7s. 4½d. Total to date, £9,186 7s. 10d.; corresponding period last year, £8,676 19s. 9d.; increase, £459 8s. 1d. Miles of track open, 3; Car miles run, 1901, 5,349; 1900, 4,992. Number of cars, 1901, 12; 1900, 11.

Dublin United Tramways Company.—The receipts for the week ending October 11th were as follows:—D.U.T. Co., electric cars, £3,765 19s. 4d.; D.S.D. Co., electric cars, £787 0s. 1d.; total, £4,552 19s. 5d.; corresponding period last year—D.U.T. Co., electric cars, £3,819 14s. 4d.; ditto, horse cars, £27 8s. 2d.; D.S.D. Co., electric cars, £884 3s. 9d.; total, £4,681 6s. 3d.; decrease, £128 6s. 10d.; aggregate to date, £74,802 11s. 5d.; aggregate to date last year, £73,756 10s. 1d.; increase, £1,046 1s. 4d. The mileage worked is 45 miles electrically, as against 43 miles electrically, and two miles by horses, for the corresponding period last year.

Glasgow Corporation Tramways.—The receipts for the week ending October 12th, 1901, were £13,255 0s. 4d., compared with £9,191 1s. 4d. for the same period last year. Aggregate since June 1st, £242,110 5s. 8d., compared with £182,007 9s. 6d. for same period last year.

Liverpool Overhead Railway.—The receipts for the week ending October 13th were £1,425; corresponding week last year, £1,510; decrease, £85. Total from July 1st to date, £24,985; corresponding period last year, £25,782; decrease £797. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

There is a fair amount of business being done in the electrical markets, notwithstanding the general depression of trade in other departments of the Stock Exchange. Members of the House are beginning to complain that it is ridiculous for them to talk about earning their bread and butter when they have all their work cut out to meet their baker's bill alone. And yet they organised a £1,000 sweepstake over the Cesarewitch! The money market remains perfectly easy, and Consols are advancing in a timid kind of way, the two factors operating together as an assistance to the Debenture stocks quoted in our lists. Electricity Supply Ordinary shares are inclined to be heavy, but the telegraph market retains the firmness of last week, and many of the deducted dividends have been recovered by the quotations of stocks marked *ex* last account day, October 11th. National Telephones are again better, and the miscellaneous list exhibits a trio of small improvements, no falls being recordable.

To particularise, Chelsea Electric Ordinary are weak, a further fall of 5s. (making ¾ in a fortnight) having reduced the price to its par value of £5. Of course the Chelsea Company has not gone out of its way, like some of the others—the St. James's, Westminster, and Brompton, for instance—to write off such sums for depreciation, &c., as to give Chelsea shares that basis of solidity that is possessed by those in the three concerns that we have mentioned. All that we are at liberty to say now is that shareholders need not be troubled about the decline in the value of their property. We shall be able to return to the subject later on.

City of Londons are relapsing after the recent flutter, the decline in price synchronising with the cessation of public interest in the market. The future of the company is so wrapped in uncertainty that it is natural for some of the proprietors to take advantage of any rise to reduce their holdings. The company's new Debenture stock is 101 to 104.

A few selling orders in Metropolitans have caused the price to recede 10s., but South Londons are the turn harder.

The Hampstead Electric Company has now gone the way which has always seemed inevitable, and the correspondents who took us so severely to task for expressing our plain views about the shares might have spared themselves the trouble of protesting. Happily, there are not many Hampstead Electrics in the financial lighting world.

In the railway market Great Northern and City Preferred "A" are better at 8¾, and a purchaser on Tuesday had to give 8½ for them. The company has come to an agreement with the Great Northern Railway which will improve its own position, and lends further weight to the suggestions we have on several occasions given—in our last notes, for example—as to the cheapness of the shares. We observe that the claims of Great Northern and City Preferred are beginning to be recognised in the financial columns of the daily press, and those who bought the shares lower down should not hurry to realise their profit. It will probably augment. Central London stocks are a good market, the rises this week being confined to the Ordinary and Deferred descriptions. The latter, considered as a speculative holding, looks high enough, but optimistic estimates of the dividend may put the price still better before the end of the year. Metropolitan and Metropolitan District stocks are virtually unchanged on the week. Perhaps the clique that is working the District deal enjoys its turf-racing more than manipulating the price of the stock for the time being. City and South London varieties are inactive, but, from the look of the market, there seems to be some chance of their prices going better.

The quotation of National Telephone Ordinary is rising through support which, to all appearance, comes from the best quarters. There is still not a shred of information to be obtained in the Stock Exchange as to the agreement with the Government, but the negotiations are the sole peg upon which the advance in the shares is hanging. The company's senior securities are not altered. Orientals, after recovering the dividend, put on another $\frac{1}{16}$ to their price.

Telegraph stocks are good. The Anglo-American group is throwing off its weakness, and the general strength of the market finds reflection in a rise in Globe Telegraph Ordinary shares. Dividends came off several of the telegraph stocks last account day, but in almost every case, part, at least, of the lost points was regained. Eastern Ordinary is once more near that level of 140, at which it always looks worth picking up. Eastern Extensions, *ex* dividend, are unchanged in price.

In the miscellaneous list, Henley's Debenture stock has put on another 1 per cent., and is ahead of Callender's Debenture to that extent. General Electric Preferences are harder, and there is some demand at a rising price for Electric Construction Preference. The traction division is quiet, but some of the "foreign" shares are better. Anglo-Argentine Trams have steadied to $4\frac{3}{16}$, Cape Electrics to 2. New General Tractions keep remarkably dull; the Ordinary are no better than 3, but at 4½ the Preference are rather less weak.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations Oct. 9th.	Closing Quotation Oct. 16th.	Business done during week ended Oct. 16th. 1901. Highest.	Lowest
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 –103	100 –103	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	78 — 83	78 — 83	...	...
822,700£	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	53 — 56	52 — 55 xd	...	...
3,088,540£	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	98 –100	97 — 99 xd	99⅜	96⅛
3,088,540£	Do. do. Deferred	Stock	18s. %	£1 7s.	5s. %	10 — 10½	10¼ — 10⅜	10 7/16	10⅜
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	5 %	3½— 4	3½— 4	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	175 –185	175 –185	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	100 –102	100 –102	101⅜	101½
16,000	Cuba Telegraph	10	8 %	7 %	...	5 — 6	5 — 6	5 7/16	5 1/16
6,000	Do. 10 % Pref.	10	10 %	...	...	13½— 14½	13½— 14½	14	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	100 –104 %	100 –104 %	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½— 11½	10½— 11½	11½	...
104,300£	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 –103	100 –103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	141 –146	139 –144 xd	143	140
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	96 — 99	95 — 98 xd	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	114 –117	114 –117	115⅝	115⅝
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	14 — 14½	14 — 14½	14⅜	14
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	114 –119	114 –119	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5½ %	...	100 –103	100 –103	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 –104 %	101 –104 %	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	5½%	11 — 11½	11¼— 11⅝	11⅝	11 11/16
180,042	Do. do. 6 % Pref.	10	6 %	...	...	15 — 15½	15 — 15½	15¼	15
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	30 — 32	30 — 32	30½	30⅛
78,000£	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 –103	100 –103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	41 — 45	41 — 45	43	42½
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	102 –105	102 –105	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	2½%	...	⅛— ¼	⅛— ¼	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	4 — 4¼	4¼— 4½	4 7/16	4 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¾— 5	4¾— 5	4⅞	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	96 — 98	96 — 99	97⅜	97
500,000£	Do. 4 % Deb. Stock Red.	100	...	...	4 %	95 — 98	96 — 9	97½	96¼
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	⅞— 1	1 1/16— 1 1/16 xd	1	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	...	...	...	100 –103	100 –103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	7½	7⅜
3,381	Submarine Cables Trust	Cert.	...	...	...	127 –132	125 –130 xd	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½	5 — 5½	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	102 –105	102 –105	...	...
171,000	West African Telegraph, 5 % Debs.	100	...	...	...	99 –102	99 –102	100¼	..
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 –103	100 –103	100⅜	100½
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14½ – 15	14½ – 15	14 13/16	14⅝
75,000£	Do do. 5 % Debs. 2nd series, 1906	100	...	...	...	103 –106	103 –106	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	103 –106	103 –106	...	...
88,321	West India and Panama Telegraph	10	2 %	⅝%	...	¼ – ½	¼— ½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	...	...	...	5 – 6	5 — 6	5	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	...	...	...	3 — 5	3 — 5	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	101 –104 xd	101 –104	101⅛	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7⅞— 8¼	7⅞— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref.	5	...	...	...	8¼— 8⅜	8¼— 8⅜	..	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10	9 — 10	9½	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼ – 5⅜	5¼— 5⅜	5⅜	5
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5 — 5½	5½— 6	5⅝	...
150,000£	Do. do. do. % Deb. Stock Red.	Stock	...	...	...	109 –112	109 –112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	6 %	4 %	0 %	9 — 10	8½ — 9½	8 13/16	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	11½ – 12½	11½— 12½	11⅝	11 13/16
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 –127	122 –127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	4 %	8½— 9½	8½ — 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13	12 — 13	...	...
200,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	104 –107	104 –107	106½	...
35,300	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5⅝— 6¼	5⅝— 6¼	5 15/16	5 13/16
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5⅛— 6	5⅛ – 6	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	105 –108	106½ –106¼	106½	106¼
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11 — 12	11 — 12	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 –104	101 –104	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1¼— 1⅜	1¼— 1⅜	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	96 –100	96 –100	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	13 — 14	12½ – 13½	13¼	13
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	112 –115	113 –116	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 – 1 0	97 –100	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15½ – 16½	15 — 16	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	15¾	15¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	..
150,000£	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	97 –100	97 –100	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 3	2½ — 3	...	...
79,900£	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	13 %	10½%	11½ — 12½	11½ – 12½	11 15/16	11⅝

* Subject to Founders Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Oct. 9th.	Closing Quotation Oct. 16th.	Business done week ended Oct. 16th, 1901 Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7 — 8	7 — 8	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	89 — 93	89 — 93	...	...
45,000	British Electric Traction	10	6 %	8 %	9 %	14 — 15	14 — 15	14⅛	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11⅜ — 12¼	11⅜ — 12¼	12 1/16	12
350,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	121 —124	121 —124	122½	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	8 — 9	8 — 9	8¼	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	...	8 %	⅞ — 1	⅞ — 1	...	...
50,000	¶ " " " 6 % Cum. Pref.	£1	...	...	6 %	1 5/16 — 1 1/16	1 5/16 — 1 1/16 xd	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅜ — 1⅝	1⅜ — 1⅝	1 9/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2 — 2¼	2 — 2¼	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	102 —105	102 —105	104½	...
108,710*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	99 —102	99 —102	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	15 — 16	15 — 16	15⅛	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5⅜ — 6¼	5⅜ — 6¼	5 13/16	5⅜
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	111 —115	111 —115	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	...	101 — 104	102 —105	104⅜	103
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	...	105 — 108	105 —108	106⅜	106½
440,100	Do. do. Def. do.	Stock	...	...	...	98 — 101	99 — 102	101½	100
855,000	City and South London Railway	Stock	2⅛ %	1⅛ %	1¼ %	51 — 54	51 — 54	53	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...		5 — 5½	5 — 5½ xd	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½ %	8 %	3 — 3½	3 — 3½	...	...
100,000*l*	{ Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red }	...	...	...	...	100 —105	100 —105	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	2½ %	¼ — ½	¼ — ½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	2½ %	1½ — 2½	1½ — 2½	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	80 — 85	80 — 85	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	84 — 89	84 — 89 xd	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅜ — 2¼	1⅜ — 2¼	1 13/16	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½ — 2⅝	2½ — 3	2⅞	2 1/16
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 —102	97 —100	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9⅜ — 10¼	10 — 10⅛	10¼	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	97 — 100	97 —100 xd	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16½ — 17½	16½ — 17½	16⅝	...
35,000	Do. do. do. 4½ % Pref.	5	...	4½ %	4½ %	5⅝ — 6	5⅝ — 6	5 9/16	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	111 —115	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	22 — 23	22 — 23	22⅝	22 1/16
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	100 —103 xd	100 —103	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½ %	3⅝ %	3¼ %	6⅝ — 7	6 1/16 — 6 1/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 13½	13 — 13¼	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500 ...	10	...	...	...	15½ —16½	... — ...	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	19/- to 20/-	... — ...	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½ %	38 — 42	38 — 42	39¼	38½
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	... %	...	104 —106	104 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	12 %	10½ — 11½	10½ — 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½ — 6 xd	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	91 — 94	91 — 94	91	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 2/—4/-
National Electric Free Wiring, 17/6 paid, ½—¾.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16.
Do. do. Pref. (£10 pd.), 10½—10⅝.

* From Birmingham Share List. ¶ From Manchester Share List.

Bank rate of discount 3 per cent. (June 13th, 1901).

MARKET QUOTATIONS, Wednesday, October 16th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,,	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£15	£15	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£22	£22	..
a Lead, Nitrate	per ton	£24	£24	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	5¾d.	5¾d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	90/-	90/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b ,, Wire, in ton lots	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £125	£75 to £140	dec.
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c Tube (brazed)	per lb.	10d.	10d.	..
,, ,, (solid drawn) ..	per lb.	8¼d.	8¼d.	..
,, Wire, basis	per lb.	7¾d.	7¾d.	..
Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£80	£80	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheets	per ton	£80	£80	..
g ,, Rod	per ton	£80	£80	..
e ,, (Electrolytic) Bars ..	per ton	£82	£82	..
e ,, ,, Sheets ..	per ton	£90	£90	..
e ,, ,, Rod ..	per ton	£84	£84	..
e ,, ,, H.C. Wire	per lb.	9¼d.	9¼d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/6½ to 3/7½	3/6 to 3/7	½d. inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	45/7½	45/7½	..
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	50/- to 52/6	50/- to 52/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£11 15 to £11 17 6	£11 16 3 to £11 18 9	dec.
g ,, ,, Sheet	per ton	£13 10	£13 10	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9	£9	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10½d. to 1/0½	10½d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£118 to £119	£115 to £116	£3 inc.
g ,, foil	per lb.	1/6	1/6	..
n ,, wire, Nos. 1 to 16	per lb.	1 8	1 8	..
p White Anti-friction Metals — "White Ant" brand .. .	per ton	£35 to £65	£35 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j ,, 6 tea. Flax	per lb.	5½d.	5½d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4 5/12d.	4 5/12d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4⅝d.	4⅝d.	..
j ,, 180 lbs. Jute rove	per ton	£10 7 6	£10 7 6	..
k Zinc, Sh't. (Vielle Montagne ord.)	per ton	£22 10	£22 10	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Walter H. Hindley & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

THE INTERNATIONAL ENGINEERING CONGRESS OF 1901.

MODERN COMMUTATING DYNAMO MACHINERY.

(Abstract of Paper read before Section IX. by H. M. Hobart, M.I.E E.)

(*Continued from page* 611.)

A rather interesting result in connection with these designs, is that relating to the cost of "net effective material" per kilowatt.

For the entire range of capacities and voltages, this varies but little from the average value of 16·3 shillings per kilowatt, being independent of the rated output, and practically independent of the voltage. But the total factory cost will be less per kilowatt the greater the capacity, since, in large capacities, the "net effective material" constitutes a higher percentage of the total factory cost.

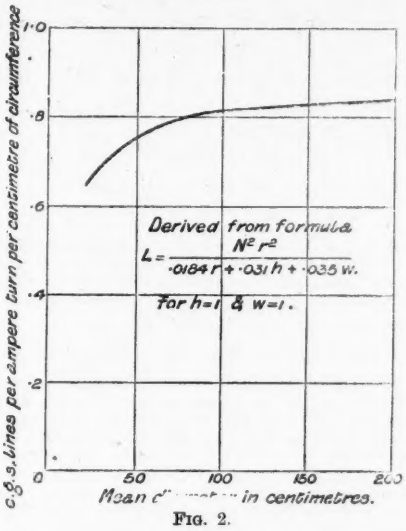


Fig. 2.

The basis on which the cost of "effective material" was calculated, is :—

	Pence per kilogramme.
Armature copper	24
Field	24
Commutator segments	24
Magnet yoke and cores (cast-steel and wrought-iron	4·5
Pole faces (cast-iron)	3·0
Armature laminations (sheet-steel)	3·6

Although for the prevailing prices it was more economical to employ cast-steel for the magnet yoke, the writer would prefer cast-iron, as he attributes great importance to stability. In some countries the relative prices for these two materials would also make it more economical to use cast-iron for the magnet yoke.

The writer believes that the cost of 16·3 shillings, on this basis, per kilowatt of "net effective material" is, for these rating,s speeds and voltages, excellent for high-grade machines.

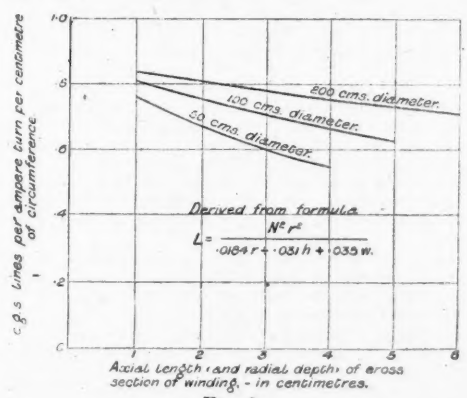


Fig. 3.

At present 115-volt machines for outputs above 200 kw. may be regarded as special, and the principles set forth need, in these larger sizes, only be considered as applying to machines for 230 volts and 550 volts.

Considerable emphasis has been laid upon the importance of low reactance voltage. This quantity not being conveniently measurable, each designer estimates it on the basis of whichever method his experience has led him to consider least unreliable. The writer proposes to describe the method which he prefers for this purpose.

Prof. Perry gives the following approximate formula for the inductance L of a cylindrical spool free in air, of N turns, whose width w, mean radius r, and height of winding h, are of such dimensions that $\frac{w}{r}$ and $\frac{h}{r}$ are very small :—

$$L = \frac{N^2 r^2}{\cdot 0184\, r + \cdot 031\, h + \cdot 035\, w}.$$

Solving this for a coil of a cross-section of one square centimetre for various diameters, we derive the curve given in fig. 2.

The curves of fig. 3 give the corresponding values for square cross-sections of coil for diameters of 50, 100, and 200 centimetres.

A few experiments have been made with a view to ascertaining how far the values given by these curves may, for rough practical purposes, be used for other than circular coils. Five coils were prepared, of the shapes and dimensions shown in fig. 4.

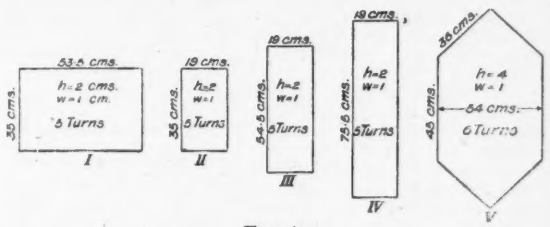


Fig. 4.

The inductances of these were measured on a 50-cycle circuit supplied from a uni-slot alternator. It was afterwards found that this alternator gave results 23 per cent. higher than an alternator giving a more ordinary wave-form, which had three slots per pole. Besides the values observed on the circuit of the uni-slot machine, there are given in Table XIV. also a set of values corrected by 15 per cent. for the purpose of arriving at more representative results.

Table XIV.

Coil.	Mean length per turn-centimetre.	Diameter of circular coil of same periphery.	Value for circular coil from fig. 3.	Value observed in uni-slot alternator with abnormal wave shape.	15% lower value to correspond more nearly to average wave shapes.
I.	177	56	·73	1·0	·87
II.	105	33	·65	1·0	·87
III.	147	47	·70	1·1	·95
IV.	189	60	·75	1·2	1·05
V.	234	74	·70	1·2	1·05

This shows the experimental values, although higher, to be not altogether different from those which one obtains by this rather free use of the formula.

The writer has preferred to work from the basis of the formula, as arranged in the curves of fig. 3. It is the *relative* values for different machines which possess the chief importance.

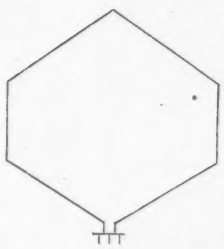


Fig. 5.

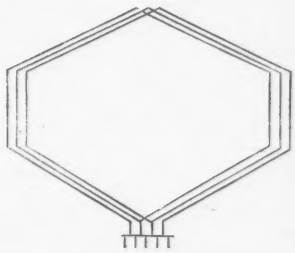


Fig. 6.

The customary shape of the coil of a continuous-current dynamo is as shown in fig. 5, and the portions lying outside of the slots will be treated as having values for the inductance per centimetre of length of some such amounts as are given by the curves of fig. 3.

As three to five segments are generally at the same time under the brush, two to four coils per brush come into consideration. Hence the complete coil on which we must reckon is much as shown in fig. 6, *i.e.*, rather spread out. A representative cross-section may be taken as having (considering the equivalent circular loop) an axial length of one centimetre and a radial depth of two centimetres, and we might take from 40 to 80 cms. as the customary range of diameters. It will be seen from the curve that, on this basis, there will be about ·7 C.G.S. lines per ampere-turn per centimetre of length for the free part of the coil.

For the portion lying embedded in the slots, various observations lead to a representative value of about four lines per centimetre of effective length.

In the embedded portion the conductors short-circuited under the positive brush lie over or near (according to the nature of the winding) those simultaneously short-circuited at the negative brush, whereas the two groups of corresponding *end-connections* are located entirely separately, as in fig. 7.

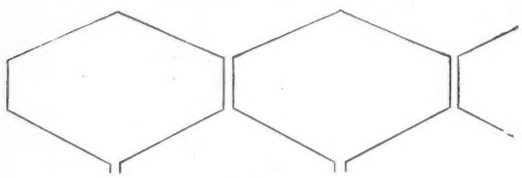


Fig. 7.

Hence the magnetomotive force acting in the short-circuited coil is twice as intense for the effective length as for the end-connections.

It has seemed best to designate by "embedded lengths" and "free lengths" respectively, the slot-enclosed portion and the end-connections, including with the latter that portion of the conductors parallel to the shaft, not strictly ironclad. In the writer's design this makes quite a difference. In this free portion, where the conductors are parallel to the shaft, the magnetomotive force is also twice as intense per centimetre of length as for the end-connections. But rather than complicate the necessarily only approximate calculations, it is preferable to take a slightly higher value, namely—

·8 C.G.S. lines per centimetre of "free length."

Take a case where three turns are short-circuited under the positive, and three under the negative brush (fig. 8):—

The mean length of one turn		100 cms.
The effective length of laminations		10 ,,
"Free length" per turn		80 ,,
"Embedded length" per turn		20 ,,
Lines per ampere turn for "free length"	= ·8 × 80 =	64
Ditto "embedded length" ...	= 4 × 20 =	80
Lines per *ampere* for "free length"	= 3 × 64 =	192
Ditto "embedded length" ...	= 6 × 80 =	480
Total lines linked with short-circuit turn ...	=	672

The inductance of one turn, in henrys, with relation to all the turns simultaneously short-circuited

$$= 672 \times 10^{-8} = \cdot 00000672 \text{ henrys.}$$

If the periodicity of reversal equals 500, the reactance equals

$$2\pi \times 500 \times \cdot 00000672 = \cdot 0212 \text{ ohm;}$$

and if 100 amperes is the current to be reversed per set of brushes, the reactance voltage per segment equals

$$100 \times \cdot 0212 = 2 \cdot 12 \text{ volts.}$$

The writer believes that here, for the first time, attention is called to two very interesting facts:—

1. That in the majority of modern machines, the inductance of the "free length" is a very considerable percentage, say 25 per cent. to 40 per cent., of the total inductance.

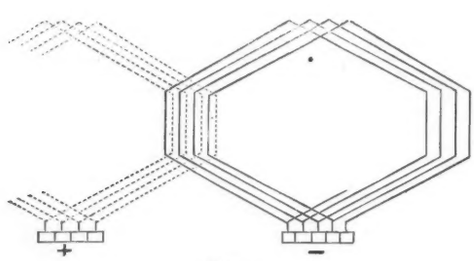


Fig. 8.

2. That, with the ordinary open slots with parallel sides, the inductance per centimetre of "embedded length" is generally only some four to six times greater than the inductance per centimetre of "free length."

These considerations lead to another of still greater interest and importance, namely, that the inductance of a coil laid upon the surface of the armature—*i.e.*, on the lines termed "smooth core" construction—is rarely much less than one-third and often one-half or more as great as in the case of the same coil laid in a slot. This is readily seen from the case already illustrated.

In the old-fashioned types the armature was very long and the end-connections but a relatively very small percentage of the mean length of a turn; but in most of the modern machines, such as the latest multipolar generators built by Mather & Platt, Westinghouse, General Electric Company, Schuckert, and others, the tendency is toward narrow armatures of large diameters, as in the case taken

(To be continued.)

REQUIREMENTS OF ELECTRICITY IN MANUFACTURING WORKS.*

By WM. S. ALDRICH, Champaign, Ill.

(*Concluded from page* 615.)

V.—Influence of Electric Drive upon Arrangement of Machinery.

The floor space required per machine or tool is reduced to a minimum.

The alignment of overhead shafting is no longer necessary.

Clear overhead room is provided for handling all classes of heavy work. The crowding and complications arising from overhead shafts and belts are avoided.

Location of machines and tools may be made to suit the requirements of the work and the available floor space. The product may then be finished with least time and labour, with least handling and transportation, and in the most efficient and economic manner.

All the conditions of work and of labour may be arranged to handle tools and material to the best advantage with freedom of workman's movements and facility in executing manufacturing operations.

VI.—Changing from the Old to the New System of Driving.

When alterations or additions in power transmission are required, it is the invariable practice in many modern shops to extend in the line of electric driving. This is notably the rule where electric supply is already at hand for either lighting or power service. In the rehabilitation of an old establishment some of the shafting transmission may usually be combined with the electric drive, as in the so-called group system. Much can be done to improve the power transmission if existing lines of shafting are divided into the most economic sectional lengths, determined by the speed, character of load, and kind of work. Electric motors will prove valuable adjuncts if installed to drive these sections independently. An electric drive is an economic and flexible auxiliary, supplementing the earlier and rigid mechanical power transmission. Such partial introduction of the new system, especially if an electric lighting plant is already in service, will early develop its advantages. It will defray the cost of installation and maintenance by greater economic production.

Scrapping the old to make room for the new involves the same economic questions in the case of power transmission as in that of manufacturing machinery. Productive machinery should not in general be scrapped while there is retained the old system of belt driving, with its inherent power and speed limitations. The increased output of the old machine, electrically driven, will frequently equal that of a new machine, belt driven, and turning out the same kind of product.

VII.—Application of the Electric Drive.

1. *Individual Driving Without Intermediate Gearing.*—The armature of the motor is mounted on the main spindle of the machine. The power is most directly applied, with ideal adaptation of tool to work.

It requires more or less special adaptation of motor to machine, with rarely any marked changes in the structural design of the latter.

2. *Individual Driving with Intermediate Gearing.*—The motor is conveniently mounted on the frame of the machine and drives it through the intervention of the ordinary gearing.

It requires no special adaptation of motor to machine. Any suitable motor may be used on any machine.

3. *Advantages of the Individual Drive.*—The workman has the most perfect control of all factors entering into the economics of production. There is maximum economy in the application of power.

The speed control and the output are independent of any other machine. They are no longer limited by the speed of the line shafting. Machines and tools may now be worked to the limits of their respective capacities.

The productive efficiency of the machine is increased. It may be operated at all times up to the power limit, reducing time and cost of labour for any given product.

The choice of the individual drive depends upon the power required, the size of the machine, the time it is in service, and the value of the product.

The individual motor drive is usually adopted where the machine is in use only part of the time, and in sizes as small as two or three horse-power, and requiring wide variations in speed and power for maximum output quite independent of the first cost. For large

* Presented at the Milwaukee meeting (May, 1901), of the American Society of Mechanical Engineers, and forming part of Vol. xxii. of the *Transactions*.

machines this method reduces the power losses to a minimum. It is particularly advantageous for shears, punches, and a class of repair shop tools requiring power only at intervals. The constructive details and design of direct-driven machines are not usually altered to any extent; secondary speed changes are obtained by the usual change-gear and mechanism; in special cases of large tools, a range of speeds is sometimes best provided by a special variable-speed motor.

4. *Group Driving.*—A few large electric motors are employed independently driving sections of shafting of the most economical length. This method is thus adapted for driving a number of small machines, with no particular requirements in speed or in power; or for most economical manufacturing along special lines; or for driving any section on overtime or night shifts; or for independent driving of separate floors, departments, or detached buildings.

The maximum economy with the group system can only be secured when all of the machines so driven are in constant use, at best speeds for maximum output. This dictates grouping machines as far as practicable of the same size, style, functions, speed and power requirements, having due regard to the work to be executed. Sectionalising the power transmission by substituting electric motors for either the main or section belts secures partial advantages of the new system side by side with the old, and is frequently resorted to in old establishments adopting new methods.

5. *Individual and Group Driving.*—The most general requirements of factory transmission can all be met by an intelligent combination of these two methods of electric driving.

The first cost of installing the individual drive will generally be from 2 to 5 per cent. higher than for the best group system, when all other considerations are the same. The individual drive is more economical in the use of power than the group system, especially if in the latter only a limited number of grouped machines are in use at any one time, at average loads.

6. *Portable Tools and Appliances.*—The extreme flexibility of the electric system invites the widest use of portable tools and appliances. A flexible heavily-armoured cable gives any desirable radius of action, with no expense to maintain as a part of the transmission system, with no danger or difficulty in handling, and requiring least time and labour for any immediate shifting of tool or work. Least used tools need not occupy floor space when not in operation Most favourable economic relations may, therefore, be secured in many lines of manufacturing work, especially of the heavier grades. Almost all required tools may be taken to and operated at the work in hand. Time is saved in not having to shift and adjust the work to the machine or tool. Several operations may be carried on at one time by bringing different tools to the work, each independently driven and operated.

7. *Electric Transportation and Conveying.*—Electric hauling by surface or overhead systems of distribution, electric conveying and telpher systems, electric cranes, hoists, lifts, and elevators, are all well-developed fields, and present no unusual or insurmountable difficulties when installed as a part of the regular electric system of a manufacturing establishment. Tools are taken to the work, or machines and tools are quickly served with material and work, reducing the cost of all handling to the lowest terms in a field of non-productive labour that has formerly been very expensive.

8. *Electric-Driven Auxiliaries.*—With an established electric supply service for all manufacturing work, it is an economic step to drive by electricity all auxiliaries, as pumps, fans, blowers, air compressors, &c.

VIII.—Selection of Equipment.

1. *Factors Determining Choice of the Electric System.*—Each manufacturing industry has its own inherent requirements. No general rules can be given, but every case must of necessity be studied and developed by itself, with a thorough preliminary survey of all conditions and requirements. One successful system cannot furnish precedent for another.

In general, the following lines of inquiry should be freely investigated before choosing any system for power transmission in manufacturing work:—The size of the establishment; the area to be served; the arrangement and grouping of shops, departments, or buildings; the arrangement, types, and sizes of machines or tools to be driven; the variety of speeds required; the character of the loads involved; the kind of work to be executed; the economics of fuel and water supplies.

The above items should have been predetermined from the standpoint of most economic production. They should in no wise be influenced by questions of power transmission. How to drive the machinery in a new and modern manufacturing plant should be a second and not a first consideration. It should be determined by, rather than itself determine, the conditions for economic production.

2. *Interchangeability Throughout the Electric System.*—It should be possible to drive similar apparatus and motors from any point of attachment to the wiring system. Greater flexibility is thereby secured, added facilities provided for use of portable tools, and readiest extension made of plant and distributing system at any time. Preferably have one, and only one, electric system if it can be secured by intelligent consideration of all present and the most probable future requirements. This does not necessarily imply that it is best to have one single circuit for all kinds of service required in a manufacturing establishment, as light and power; but it should not be required to use different circuits for the same service, as portable tools.

3. *Uniformity of Electrical Equipment.*—Generating sets and motor equipments should be standardised as far as possible in the case of any given establishment. These machines, as well as their parts, should be readily obtained in duplicate at any time. This is particularly important in making additions and extensions in the group system, where it may be required to change from a smaller to a larger motor at any time to accommodate more machines on a given section. It cannot be advantageous to experiment with different styles and types. Electrical machinery to-day is so far standardised, and its performance predetermined, that there can be no excuse for not selecting that style and type best adapted to any given factory.

4. *Power Required as a Basis for Size of Electric Motor.*—The load diagram for any machine will furnish the best data for determining the proper size of motor. It may be readily obtained under the working conditions of the machine by using a test motor.

In almost all metal-working industries the power required is subject to extreme fluctuations, and may be very heavy, at times, while the bulk of it will be quite light. It is not necessary to instal an electric motor to carry, for any length of time, such sudden and heavy loads as will be shown by the peaks of the load diagrams for the several machines, or the sudden initial throw of the ammeter needle.

The limit of overload is fixed by the allowable rise of temperature, and can readily be predetermined for any given electric motor. In general, the surface temperature of the motor field coils, as measured by a thermometer, should not exceed from 35° to 45° C., with a maximum limit of 50° C., after an overload run of from 6 to 18 hours, as may be specified by the builders.

Starting load currents are, of course, high, and may be from two to three times the normal current, as in the case of overloads, for brief periods. Individual drives require proportionately larger motors to enable them to carry alone the heavy overloads. Group drives require only normal load motors, as it will rarely ever occur that the several grouped machines are all carrying overloads at the same instant. Motors for this service may often be much smaller than would be dictated by the combined load diagram of the machines forming the given group or section. In no case will they require to approach the maximum, or the sum of the maximum, loads of the various machines. Group system load curves will be smoothed out considerably. In all electric motor installations there should be ample power provided, rather than a narrow margin only to work upon. Increasing loads are almost sure to arise in time. A motor of ample size gives that reserve power so characteristic of the electric system, if properly installed.

5. *Character of Loads in Manufacturing Work.*—Load curves and diagrams of individual machines, groups, sections, and the entire plant, can only be relied upon in estimating the character of loads being carried, or likely to be carried, under similar conditions. The load factor, the ratio of the average to the maximum load, for any given time on any given part of the system, should be as high as possible for best working efficiency and economy. It may be largely influenced by the way the operator handles his motor. Whatever the kind of load, uniform or variable, light or heavy, continuous or intermittent, suddenly fluctuating or periodically variable, it must be carefully investigated before installing electric motive power. In certain instances, fly-wheels may be useful, for the same mechanical reasons as elsewhere employed in machinery.

6. *Speeds of Manufacturing Machinery.*—The speeds should be predetermined by the conditions for most economic maximum output, and so fix the range required for the electric motors. In no instance should the reverse be the case. In many cases of individual drives it may be best to obtain the speed reductions mechanically, as by the ordinary change-gear. It is not necessary nor advisable in all cases to secure the same by mounting the motor armature directly on the spindle of the machine. Provide motors with speeds consistent with the range of change-gear, and gear down rather than up.

7. *Electric Generators Required in Manufacturing Plants.*—The style and type should be largely determined by the kind of service to be supplied, the size by the normal and overload conditions as shown by the plant load diagrams, with due considerations given to special conditions and variable loads.

The actual normal capacity of the generator will be chiefly determined by the length of time the various motors are in use, rather than by their normal or aggregate capacity. It may happen, owing to the intermittent use of machines and motors, that the generating plant may be reduced to 50 per cent., or even to 20 per cent. of the aggregate normal capacity of the motors out in the establishment. An increase of the electrical system can only be intelligently made from a careful study of the load curves of the existing installation, and using it as a basis for comparison with the probable load curve under the proposed conditions. There should be judicious subdivision of the generating plant into units, preferably of the same size and style, that they may be readily interchanged and duplicated at any time, with one or two relay units for emergencies and extra rush seasons of work. All generating units used in manufacturing installations will necessarily be of such size as to warrant their being driven by direct connection to engines or turbines. If generators required are too small to warrant direct connection, the establishment is too small to warrant an introduction of the electric drive.

8. *The Electric Wiring and Distributing System.*—All wiring should be done in accordance with the "National Electric Code," being the rules and requirements of the National Board of Fire Underwriters. Separate service circuits, from the same or separate bus bars, may be provided to advantage, for lighting and various power uses. Sub-stations, or sub-station switchboards, should be provided for separate shops, floors, departments, or buildings, making it unnecessary to run a separate set of wires back to main switchboard for each service.

9. *Indirect Electric Distribution.*—Indirect distribution, through the use of accumulators, converters, or transformers may be found expedient under certain conditions. For the three-wire systems, some type of accumulator or motor-generator balancing set is almost essential for efficient regulation. The accumulator may render as

invaluable service in certain kinds of factory installations, such as iron and steel mills, as it is now rendering in traction work, where the character of the load variations of the former is somewhat analogous to that of the latter. The loss in the battery is very small and entirely negligible compared to the advantages to be derived from its use in manufacturing plants of the type mentioned.

IX.—Losses in Factory Transmission.

The inherent losses common to all systems of factory transmission are due to the intermittent and irregular use of the machines driven. These are reduced to a minimum with the electric drive. There is no consumption of power when the motor and machine are not in operation. There are no power losses when the motor is not in use, no so-called dead load losses, due to mechanical friction of the shafting system, no transmission losses in the line when the electric current is not required.

Electric generators and motors, when in operation at uniform speeds, have, generally speaking, but two kinds of losses; the first is a constant quantity depending upon the size and type of machine; the second is a variable loss proportional to the square of the current in the armature circuit. The electric line and other wiring has a loss proportional to the square of the current carried. The cost of waste power in the mechanical system becomes excessive at light and frictional loads. It is saved in the electric system, in which the constant losses are minimised and the variable losses are throughout proportional to the amount of work being done.

X.—Efficiency of Electric Transmission.

The efficiency of the electric system under normal conditions shows high maintained values, from about 25 to 35 per cent. underload to the same amount of overload, for the individual generators and motors, as well as for the aggregate efficiency of the installation. In mechanical transmission there is a constant falling off in efficiency at various underloads in every part of the system, owing to the inherent losses due to mechanical friction, which losses are constant at all loads and constant speeds. It is not a question so much of the individual efficiencies, in either case, as of the aggregate or combined efficiency, from engine or turbine shaft to machine or tool. The performance should be considered and compared at proportional parts of the full load as well as at normal loads. The mechanical efficiency of all manufacturing machines is almost invariably low. It is possible materially to affect it by efficient motors properly selected, installed, and operated.

The all-day efficiency may be made higher with the electric drive than with any other system, as the amount of time is minimised during which machines and tools are necessarily idle.

XI.—Operation and Testing of Factory Installations.

1. *The Generating Plant.*—As far as practicable, each unit should be operated at its normal capacity—additional units to be switched in as may be required by the manufacturing conditions.

2. *The Motors.*—Rarely the case that any machine or tool is started from rest with full load upon it. Motors may be started best under the usual friction, or light loads on the machines, as in the belt systems. When the machine is brought up to proper speed, work may be thrown on to it. In this respect the practical operation of an individual electric drive follows closely that of the belt system.

It is always possible to tell exactly what is going on in an electric drive, both in kind and amount of useful work, as well as in the matter of wastes and losses. Power measurements are made at any point by ammeter and voltmeter, or by a wattmeter alone. A special test motor of known performance lends itself admirably to comparative tests of the performance of machines and tools under various conditions. Workmen may know at any moment whether they are driving tools or machines to best advantage for maximum output at best speeds.

The definite power required for definite work may be determined and charged to each machine, tool, or piece of work, and so make up the shop cost of production more exactly than by any other system. The power lost in friction of individual machines when running empty may be obtained with equal facility and compared with that required in doing useful work. It will be found that the latter increases almost directly as the resistance being overcome by the machine in its operation under working conditions. The power required by the work is a small per cent. of the total power delivered to the machine.

LOSS IN ECONOMY BY THE INEFFICIENT COMBUSTION OF FUEL.*

By A. Bement.

All technical effort tends toward a commercial achievement, and it is by this means that the value of any method or apparatus must be measured; if any technical process has a commercial value, it will surely find adoption as fast as the intelligence of the time will allow. The possibility of more economical use of fuel being accomplished by a better understanding of the combustion process, is one of those problems which must be measured by a commercial standard instead of being viewed from a distance as an abstract technical matter.

If the present prevailing practice with boiler furnaces has reached, or nearly approached, perfection without the aid of gas analysis, it necessarily follows that there would be no occasion for more advanced study of the matter; if otherwise, it should certainly be the privilege and opportunity of the engineer or station manager to avail himself of the advantages of methods and means of determining the influence of the furnace conditions as affecting efficiency.

The performance of a steam generating apparatus is usually looked at from the standpoint of what it does do, rather than what it does not do; and a brief examination of the source of the more important heat losses with stationary boilers may be profitable. The largest and most important of these is by the chimney in products of combustion; in air which has not been used, and by combustion gases escaping unused. This loss by the chimney should never be greater than 22 per cent., but may in some cases be as low as 12 or 15 per cent.; even if the justifiable loss be limited to 22 per cent., and the losses of combustion in the ash, radiation, moisture in the air, fuel carried over the bridge wall, heat lost by burning hydrogen in the fuel, &c., be placed at 8 per cent., there would be left 70 per cent. for useful work, which would be a reasonable, every-day performance for an ordinarily good apparatus. How near does prevailing practice conform to this? Let the station manager or engineer put this question to himself, and see how near he can answer it; not by estimating or guessing, but from actual knowledge of his own conditions. His answer to himself will show him how well he knows whether a study of the furnace performance is useful or not.

The losses, except those by way of the chimney, may be considered in a large measure as fixed losses; the loss due to unburned

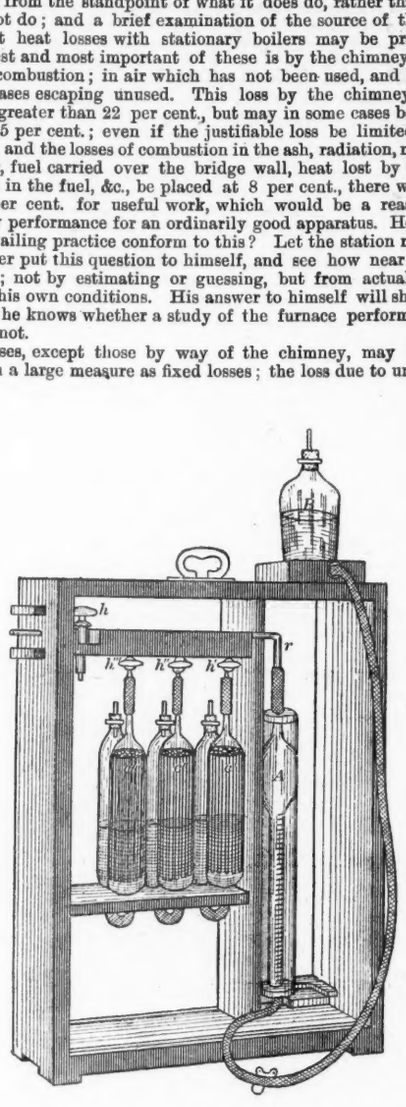


Fig. 1.—Orsatt's Apparatus.

combustible in the ash may vary somewhat, but it is the one loss which generally receives the most attention, because the coke in the ash is readily visible. This loss, therefore, may be considered in a measure as a fixed one, while that by the chimney is the varying, as well as the largest loss.

The relative constituents of the escaping gases, as shown by analysis, should run, for good results, between the two compositions following:—

	A	B
Carbon dioxide (CO_2)	11 per cent.	15 per cent
Oxygen (O)	8 „	4 „
Carbon-monoxide (CO)	0 „	0 „
Nitrogen (N)	81 „	81 „
	100 per cent.	100 per cent.

Between these two conditions there would be a difference in heat loss, with gases leaving at 600° F., of about 4·5 per cent., but if the combustion should be as follows:—

CO_2	4 per cent.
O	15 „
CO	0 „
N	81 „
	100 per cent.

the loss would be 45 per cent.

* *American Electrician.*

The above compositions are with complete combustion, but if combustion is in any measure incomplete, the loss will be greater.

Let the engineer in charge of boilers ask himself how near complete is combustion in his case, and what is the average per cent. of carbon dioxide in the gases; his answer to himself will help him to come to the conclusion whether he desires to employ gas analysis in the operation of his boilers or not. If he decides that he does, he will have a choice of several instruments.

The most convenient and useful instrument for determining the proportions of CO_2, O, and CO in furnace gases is the Orsatt apparatus, sold by all chemical supply houses. This is only one of a large number of instruments designed for the same purpose, but differing in some manner; but it would be the only instrument that the engineer would be justified in considering. Fig. 1 shows such an instrument. The burette, or measuring tube, A, contains from its zero mark at the bottom to the upper capillary end, exactly 100 cub. cm.; but its graduation (in $\frac{1}{5}$-cub. cm.) extends only to 40 cub. cm., and ceases when the tube is enlarged. In order to guard the gas in this burette from the influence of changes in external temperature, the tube is surrounded by a water jacket closed at the top and bottom by india-rubber stoppers, and provided with a white background of milk glass, against which the black scale divisions on the burette are plainly visible. The bottom of the burette is connected by an elastic tube with a level bottle, B, which is two-thirds filled with water; the top end of the burette is connected with a glass capillary, *r*, bent at a right angle, and ending in a three-way cock, *h*. This tube is protected against breakage by a wooden frame, and carries at right angles three taps, designated *h'*, *h''*, *h'''*, each having capillary tubes, and connected by inside rubber joints with three U-shaped absorption vessels, *c'*, *c''*, *c'''*, each of which is filled with a bundle of glass tubes. The vessel, *c'*, contains a solution of caustic potash, and absorbs the carbon dioxide (CO_2); *c''* contains an alkaline solution of pyrogallol, and absorbs oxygen (O); *c'''* contains a concentrated solution of cuprous chloride in hydrochloric acid, and absorbs carbon monoxide (CO). In order to keep this latter solution in an unchanged state, it is left in constant contact with copper spirals introduced into the glass tubes in *c'''*. Sticks of moist phosphorus may be used in the tube *c''* for absorbing the oxygen in place of the alkaline solution of pyrogallol, in which case the glass tubes within the absorption vessel are unnecessary.

The absorption vessels are half filled with the chemical. This is drawn up to the mark made in the capillary neck by opening the connecting tap and running off the water in the burette A, for which purpose the level bottle, B, must be lowered. In making a test, the level bottle, B, is raised, the tap, *h*, opened, and the burette, A, filled with water to the capillary part. The outer end of the capillary tube is connected with the tube through which the gas is to be led, and the lower end of the three-way cock, *h*, with a hard rubber pump by which the air is removed from the conducting tube. The gas is aspirated by lowering B and turning *h* through 90°. The water is then run off to a point a little below zero; the tap, *h*, is closed, and the gas compressed by raising B till the water is above the zero mark. The india-rubber tube is then squeezed close to the joint by either the fingers or a pinch-cock, and after lowering B, water is permitted to escape by cautiously loosening the elastic tube, until the level falls to the zero mark. The tap, *h*, is then opened for an instant in order to equalise the pressure inside the apparatus with that of the atmosphere, whereupon exactly 100 cub. cm. of gas will be confined in the burette.

Absorption now begins. The gas is conveyed into the absorption tube, *c'*, by raising B, and at the same time opening *h'*. By causing the gas to travel back and forth from *c* to A the absorption is expedited. The reading is taken by raising B until its contents are on the same level with the water in the burette, A. The decrease in volume indicates directly the percentage by volume of carbon dioxide. In the same way oxygen is absorbed in *c''* and carbon monoxide in *c'''*. The residue which remains unabsorbed is principally nitrogen. Full directions for use of this instrument are given in a little book by Prof. A. H. Gill, entitled "Gas and Fuel Analysis for Engineers."

The engineer might find a gas composition A:—

A.

CO_2	5·0
O	15·0
CO	0·0

which would show that combustion was complete, but that air was in very large excess, or he might get the composition B, showing both incomplete combustion and an excessive amount of air.

B

CO_2	6·0
O	11·5
CO	1·5

With an obstruction of ash and clinker on the grate he might find composition C:—

C.

CO_2	7·0
O	10·0
CO	2·0

Or he might find the very favourable condition:—

D.

CO_2	14·0
O	5·0
CO	0·0

Just after coaling the fire the showing might be as below:—

E.

CO_2	11·0
O	6·0
CO	2·0

After this fire had burned low and before replenishing, the composition would often be represented by

F.

CO_2	2·0
O	17·0
CO	0·0

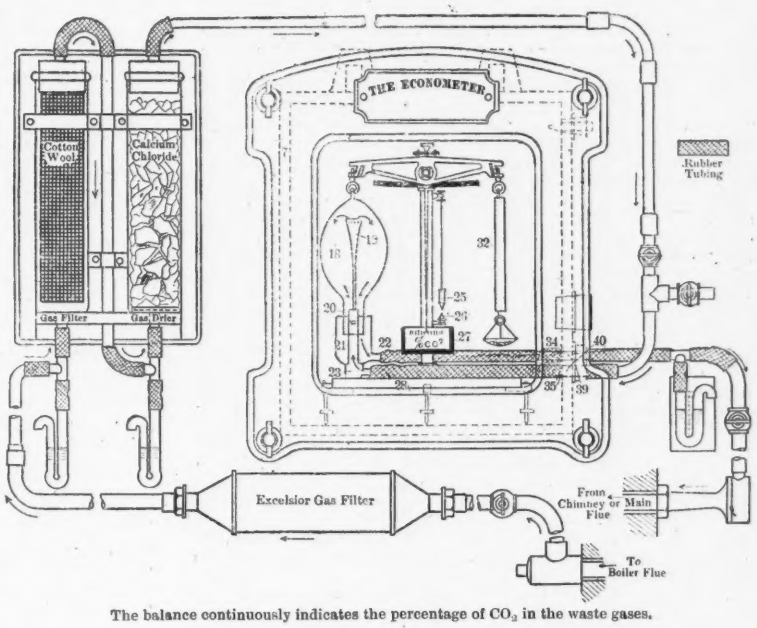
(*To be continued.*)

THE AUTOMOBILE CLUB AND ELECTROMOBILES.

The following is a copy of a letter written to the Editing Committee of *Automobile Notes and Notices* by Mr. Theodore G. Chambers, of Bloomsbury House, W.C.:—

To the Editing Committee Automobile Club Notes and Notices.

Sirs,—The Automobile Club was founded in the general interests of automobilism and not for the benefit of any particular class of car. What has been its attitude towards electric cars, and how has this branch of the industry been treated? The first official trials of electric vehicles were conducted by the Club in connection with the Richmond Show in June, 1899. The arrangements made on this occasion for charging and housing the cars were notably inefficient.



The balance continuously indicates the percentage of CO_2 in the waste gases.

Fig. 2.—Arndt's Econometer.

The second series of electric trials was held at Chislehurst in November, 1900. The conditions under which these trials were held have become notorious. An absence of practical knowledge on the part of the Club officials as to the requirements of electric cars was manifested. Manufacturers were, in the first instance, consulted as to the advisability of holding these trials, but their advice was not sought on any of the material points connected with their conduct. For the first time (and it is to be hoped for the last) owners of cars were kept in the dark till within two or three days of the event, not only as to the district in which the trials were to be made, but as to the whole of the conditions under which carriages were to run. No indication was given as to the class of car it would be desirable to enter, and as one result of this unprecedented rule, many carriages were entered which were totally

unsuited for the routes selected. In spite of the fact that the entrance fees were heavy (two firms alone paying an aggregate sum of £73, exclusive of current), no suitable accommodation was provided for the cars at night at a time of year when inclement weather might have been expected. No opportunity was given for owners to provide accommodation for their employés engaged during the trials, and owing to knowledge of the district being withheld, no sufficient opportunity was given to the Press or the public to be present. An impression was consequently created that electrically-propelled vehicles were still in an embryo stage, and that the trials could only be considered as experimental. This was contrary to fact, as many costly and efficient vehicles were present, and the results of the trials conclusively proved the practical character of the electric car. We now come to the third occasion on which the Club has dealt with electrical vehicles. At a meeting held at the Automobile Club last year to consider the "Great Event of 1901," special application was put forward to allow the representation of electrically-propelled cars. It was not, however, till July 25th, 1901, that owners received any intimation that a class had been established for electric carriages. The entrance fee of £20 per vehicle was requested before August 1st. On July 27th a letter was sent to the secretary of the Club, from which the following is extracted:—

"The car will require each night a charge of 30 amperes for 10 hours, the voltage being 120 to 130 volts. We shall be glad to know whether arrangements will be made by the Club with the Exhibition authorities for the supply of current, or whether we shall make our own arrangements with the Corporation."

The official reply of July 29th was as follows:—

"I am making inquiries concerning current at Glasgow," and on August 17th, in reference to a question as to charging at intermediate points upon the trial routes, the secretary wrote:—"The Club cannot be responsible for the charging arrangements at any places except Glasgow," thus distinctly assuming responsibility for provision at Glasgow.

On arriving at Glasgow on August 30th, it being the Friday before the trials, it was found that no arrangements whatever had been made in respect to charging electric cars.

At the Glasgow Corporation electricity works nothing had been heard as to an electric car requiring current in connection with the automobile trials. The club officials, it may be, surprised at an electric car reaching Glasgow, had no suggestion to make. Excuses were varied and various. It was said that no one knew what current was required, but the letter of July 27th above quoted, specifically and clearly stated what current was wanted. It was urged that a representative of company had volunteered to make the arrangements. In view of the official replies of July 29th and August 17th no agent had been authorised to deal with Glasgow, and, as a matter of fact, the company's Edinburgh representative, Mr. Townsend, had neither spoken to nor seen the club officials on the matter. Even at this stage, namely, on the Saturday previous to the trials, which began on the following Monday morning, no assistance was rendered by the club officials, who from that time ignored the whole question. Owing to the kindness of Mr. J. C. A. Ward, the mains superintendent of the Glasgow Corporation (in the absence of the chief engineer), the car was at last able to charge standing in a street outside the Corporation works, surrounded by a crowd of vagrants and children. Charging was naturally conducted with some difficulty.

On Monday Mr. Townsend came over from Edinburgh, and he and Mr. Ward spent the whole day in making arrangements to charge inside the Exhibition during the week. By the courtesy of the authorities permission was given for the car to stand during the night in the Machinery Hall, but as it could not be admitted until after the official closing time, charging could not begin till 10.30 p.m. Up to this hour the car had to remain every night in the open, often with batteries discharged, and then the charging had to be rapidly conducted. Greater difficulties were thus introduced than were encountered at any time on a tour of 1,200 miles. To render the official neglect less excusable the Corporation engineers stated that had they had a week's notice everything might have been in readiness for the car to charge at one of the sub-stations at any hour and under adequate shelter.

No explanation has been given by the club officials up to this date, and one may well ask what is the object of an entrance fee of £20 if it is not to secure adequate accommodation for the cars entered for trial? It may be here stated that all expenses of housing the car, supplying electricity and night attendance were borne by the owners of the car in addition to the payment of the entrance fee.

As will be seen from these notes the electric car cannot be said to have received that consideration from the Automobile Club of Great Britain and Ireland which have been bestowed on other forms of carriage. Electricity has been recognised by the Automobile Club de France as a motive power for self-propelling vehicles having a great future before it, and trials of electric cars have been conducted in Paris with marked success. Once again the necessity has been demonstrated for the formation of a special committee in connection with the Club to deal with electric cars and their requirements, and to superintend trials in which they are engaged.

THEODORE G. CHAMBERS.

London, *October*, 1901.

Acetylene.—An International Acetylene Convention is being organised by L'Union Française des Acetylenistes, to be held in the premises of the Société des Ingénieurs Civils, in Paris, on the 21st and 22nd inst.

TRAMWAY POWER CALCULATIONS.

ANYTHING that helps to determine the power necessary for electrical traction is welcome. An esteemed contemporary publishes a sheet of curves by Mr. A. G. Hansard for the purpose of determining the power and speed of cars under different conditions of speed and gradient. For this purpose Mr. Hansard has assumed 30 lbs. per ton as the resistance of air, track and journals. The diagram shows the following:—

1. Given weight and gradient, the draw-bar pull is found.
2. Given speed, the brake horse-power is found.
3. Given the electrical efficiency of the equipment, there is found the current at 500 volts.

An example is given of the use of the tables as follows:—

A car of 13 tons on a gradient of 1 in 125 requires about 625 lbs. pull. At eight miles per hour this is found to be 13¼ B.H.P., whence is found about 12 KW. at 80 per cent. efficiency, or nearly 25 amperes at 500 volts. Should any other resistance figure than 30 lbs. per ton be deemed desirable to adopt, it will be easy to correct the result proportionately.

To allow for acceleration, it should be remembered that an acceleration of 1 ft. per second per second is equivalent to a gradient of 3·1 per cent. Thus acceleration can be allowed for by increasing the gradient. It is also convenient to remember that an acceleration of 1 ft. per second per second produces a velocity of 10 miles per hour in the course of about 15 seconds. The scales are logarithmically divided, so that the same percentage of accuracy is attainable throughout. The diagrams only profess to be useful for one car; that is, they make no pretence of being of use in estimating station capacity. We think that perhaps the figures they give will be found to err on the side of moderation, but it is really very difficult to arrive at conclusions as to the power required per car. The usual consumption of energy by a 7-ton car, under average conditions, is 1 unit per car mile, or about 6 units per hour, all inclusive. It seems probable that for a car of 13 tons at 8 miles per hour, more than 25 amperes at 500 volts will be required up a gradient of 1 in 125 on ordinary town rails, though for clean rails the figures appear good. Still, as said above, allowance can be made for varying conditions.

Practical tests are wanted to determine the resistances of electrical cars. From figures before us we should say, further, that such tests ought to include trials made on cars with the motors disconnected, in order that the resistance of the mechanism may be found, as we believe the gearing to be responsible for very heavy absorption of power, which, if realised, might lead to better construction of gears, bearings, &c.

RECENT TRAMWAY PRACTICE.

THE following notes were suggested by Mr. James More's paper read in Section VII. of the Glasgow Congress:—

Rails.—The Table given in the paper shows no particular improvement in the physical qualities of rails between 1891 and 1901, but it does show the necessity for tests. For instance, 98-lb. rails supplied to Glasgow this year gave elongations varying from 8·00 per cent. to 17 per cent., and a contraction of area varying from 14·50 per cent. to 43·4 per cent.

Steel for rails contains from ·55 per cent. to ·65 per cent. of carbon, has a tensile strength of 45 tons per sq. in., with 15 per cent. elongation, and a contraction of 40 per cent. in a 2 in. × 2 in. test piece.

It is hardly necessary nowadays to insist on a fairly heavy section. Toronto has a curious rail history. In 1892 she put down rails weighing 98, 69, and 67 lbs. per yard, but the decreased weight seems to have taught its lesson, for in 1894 rails of 73 lbs. and then of 86 lbs. were tested. One does not envy the permanent way superintendent if he has to work with five different sections. Rails used to be light and short. They have become heavy, but there are not a great number exceeding 45 ft. in this country, and there are all too many ranging upwards from 24 ft.

The only conceivable disadvantage with rails so long as 60 ft. is found in carrying them from the works to the tramway. If they are made in England much of the disadvantage vanishes. Permanent way engineers grumble at having to lay these long rails, but their conservatism, or their lack of energy, or of talent to adapt themselves to the change, must not be allowed to stand in the way of an improvement. Joints are the expensive things in laying and in maintaining track. The fewer there are the longer will be the life of the rails and of the rolling stock, and the less the expenditure in maintenance.

Periodically the continuous rail is boomed, and

we wish it every success, whether obtained by means of the cupola cast or the thermit cast or the electric weld. At present we know only that the two oldest are very expensive, and that the Goldschmidt process is very alluring, and very young. Till the ideal is obtained we must try to join up our rail-ends in the best way, and the number of methods, or variations of a few methods, open to us is in number rather more than the sands of the seashore. There is the "cut-joint" method, the "sole-plate" method, and the "fish-plate" method; inventors having spread themselves chiefly on the last, producing some really astonishing designs. Most of them come from America, and lead one to the conclusion that the general condition of the permanent way over there must be dreadful.

If the foundation for the rails is laid well and truly, much of the need for joint support is gone. It is very desirable that the surface beneath the rails themselves be free from irregularities, and that is the point on which the "cut" or "check" joint scores over the sole-plate.

A well-founded permanent way will pay for itself when the cars are running. Make sure of getting the joints well packed in the first place, for a joint packed while the cars are running will never last.

In the majority of cases the concrete bed is floated, and finished smooth. The better plan is to leave the surface rough to make better bond with the setts. A bricklayer would certainly suggest that.

All tramways are paved either with setts or wood blocks, and with both materials pitch grouting is used, instead of the old time, inelastic cement grout. Pitch grouting is too often carelessly done, as much being run over the surface as between the paving blocks. This leads to trouble with the first hot sun. In order to avoid the bubbling up of the pitch in hot weather, some engineers pour the pitch within 1 in. to 1½ in. of the surface, filling in the remainder with fine concrete carefully brushed in. In this way the under-bed is kept watertight, and pitch does not spread on the track.

Setts should be laid with close joints. If wide-jointed, they are soon worn to a rounded surface.

Toothed margins are an abomination to the owners, as well as to vehicular traffic and bicycles. Wherever the track is not paved right across, it should have flush margins.

Special work, as it has been christened in America, is fairly well standardised in England. This is not to say that it has attained perfection.

Points and crossings generally are made of cast-steel, but it cannot be said that their wearing qualities are satisfactory. In single-line work, with passing places at frequent intervals, the special work item runs up the cost per mile considerably, and every endeavour should be made to secure good material for long life.

In the steam days two dummy points were used as a rule, but we see now, everywhere in England, one dummy and one movable point, with a spring point at turnouts.

The Germans seem to favour double movable points, and we are inclined to agree with them, as a tongue is inexpensive to replace, while our dummy points, when worn, must be renewed entirely.

The built-up crossing is still in unfavourable evidence in Germany, but has been rightly superseded over here.

Bonding has been recognised as essential, and enforced as imperative, for not many years. One cannot think it was considered to be either useful or necessary in the days when a bit of No. 8 iron wire was squeezed under a bolt head on each side of a joint. One has heard of a short line, "bonded" like that, where the drop could not be contained in two 10-volt recorders in series.

Nowadays we put two heavy copper bonds (3/0 or 4/0) across each joint and cross-bond the rails every 100 to 150 ft. When, after all these precautions, the drop threatens to exceed a reasonable limit a negative booster is placed at the end of a track feeder.

Overhead Construction is tending to the heavy side. Some recent examples seem almost too heavy, especially as regards the poles.

An idea has arisen that span-wires are necessary more to pull the poles straight than to support the trolley wires.

We should like to see spans not strained up to 600 or 800 lbs., and the poles less cumbrous. A dip of 9 in. to 12 in. in a span-wire is not unsightly.

Poles are made most generally in three sections, one shrunk and swaged over the other. They are planted 6 ft. deep in a concrete bed.

Mr. More objects to the test in which the jointed pole is dropped through 6 ft. vertically on to a hard surface. Old custom calls for this test, and it was required when poles were "planted" by a multitude of men handling precarious props. Our methods at present are less crude.

Probably the trolley wire is as good as it ever will be. It is hard drawn, high conductivity copper, with an ultimate tensile strength of from 22 to 25 tons per square inch.

No. 0 wire, having a diameter of ·324 in., has been used as a rule, but new lines are being constructed with 00 wire, diameter ·348 in. The difference in weight is only 260 lbs. per mile, while it is cheaper to run extra copper above than below ground.

In this country we have experimented very little with other than circular trolley wire. In America, however, where a perfectly smooth running surface is required on account of the higher speed of the trolley wheel, wire having a figure 8 section has been used. These fancy sections are very difficult to handle.

To support the trolley wire, insulated hangers, of an endless variety of form, are screwed into ears which are either soldered or clipped to the wire. If well done, the soldered ear is the best. It is very easy for an ignorant or careless lineman to lay up a store of mishaps to worry the unfortunate running engineer.

If clip ears are used the halves should be rivetted together, not screwed as in many places on the Continent.

Hanger caps should be locked in some way, otherwise they tend to work off with the vibration of the line. The insulated bolt then unscrews, and the trolley wire falls.

There should not be in the overhead equipment any article made of iron or steel, unless thorough and frequent painting is ensured. Much trouble is being caused daily by set pins that have rusted in, turnbuckles that will not turn, and by all the damage that unchecked oxidation can compass.

The suspension of trolley wires is carried out in several ways; but, whenever centre or side-bracket arms are used, the trolley wire should be supported flexibly, as with the span wire construction, as it is saved thereby from the shocks of the trolley-wheel, and efficient double insulation can be obtained. It is quite unnecessary to keep entirely to one system on any line, and judgment should be used as to whether brackets, arms, or span wires are better suited to any particular spot.

There are two distinct systems of construction, viz., that for a side running, and that for a centre-running trolley. Possibly because a royalty has had to be paid on the former, the central method has been adopted chiefly. Undoubtedly the side-running system lends itself to invisibility and other things more readily than its rival, but the swivelling head, which made the system possible, has not been too satisfactory.

Cables are laid on the solid system, or on the draw-in system, cables laid directly in the ground being hardly ever used. The draw-in method seems to be the more advantageous. With the solid system cables are laid in wooden troughs, or in glazed earthenware half-pipes carefully jointed, and filled in with bitumen, a wooden cover or bricks being laid on the top.

Cast-iron pipes, or earthenware conduits, running into draw boxes spaced according to circumstances, are used on the draw-in system, and spare ways are generally laid in the beginning. With the solid system, such provision for the future is impossible.

Multiple core telephone and pilot cables accompany the feeders. These should be looped through every section box, if laid on the solid system, to permit testing and location of faults to be carried out with ease.

It is a great mistake to make up the pilot (rail drop) wires with the telephone wires, as the constantly varying currents of comparatively high intensity in the former will aggravate the usual induction troubles in the telephone circuits.

Separate feeders for distinct routes are desirable, as a fault on one route can then be localised.

Cars.—The majority are single-truck double-deckers. Gradually we are being converted to double-truck cars, chiefly of the so-called maximum traction type. Some day we shall rise to cars having two equal-wheeled trucks, with four motors in all.

Cars are being turned out so fast to-day that well-seasoned wood cannot be used in all cases, and there will be many ready for firewood before their time.

Motors are all single reduction geared, generally 4¼ or 4½ to 1. They vary from 17 H.P. to 35 H.P., but the majority are near the lower figure. The motor cases are supposed to be water and dust-proof, but they frequently are not.

Carbon brushes are used in a rigid brush-holder. Owing to the great vibration, the pressure on the brushes has to be much heavier than with stationary machines, so the brushes wear quickly. On this account the carbon is made harder; but it seems to be false economy to save brushes at the expense of commutators.

Controllers are invariably of the series-parallel type, with magnetic blow-out arrangements. In most cases it is possible to short-circuit the motors for an emergency stop.

Brakes, till recently, acted only on the wheel tread and were applied by hand-worked levers. Now we have hand and magnetically-operated track brakes, and electric brakes operating through resistances, or by magnetic friction discs, always obtaining energy from the motors, which, for the time being, become generators.

It is necessary to disabuse Mr. More's mind of the notion that the action of the electric brake is dependent on a supply of power from the trolley wire, especially as he makes this imaginary dependence an argument in favour of the air brake.

If electric brakes are to be used continually, it should be remembered that, as things are now, motors are as small, and as highly rated, as they can be, and some allowance must be made for the increased work they will have to do when used to retard as well as to accelerate. An ill-used electric brake will do more damage to the motors in one day than will the fair use of those motors, as motors, in several months.

It is very hard to accustom drivers to the fact that the electric brakes will skid the wheels just as well as the hand-brake, unless the same precautions are taken.

Power House Plant.—The need for quick steaming water-tube boilers is not felt on a pure traction load, the peak being either absent or insignificant. Lancashire boilers are therefore suitable, but it is doubtful whether many will share Mr. More's predilection for the Galloway tube.

Generators are, as a rule, continuous current multipolar, supplying at 500 volts. Extensive, complicated systems must be supplied by high pressure alternators delivering to transforming and converting sub-stations, and the day is at hand when "one tramway, one power station," will apply even to the largest systems.

It is unnecessary to touch on other details of the power plant, as they are common to lighting and traction.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

19,440. "Automatic cut-out device for overhead trolley wire as used for electrical traction." W. Halliwell. September 30th.

19,445. "A new or improved electric light numbering machine." F. J. Borland and T. G. Morton. September 30th.

19,461. "Improvements in transmitting and receiving apparatus for Hertzian waves." E. Ducretet. September 30th. (Complete.)

19,462. "Improvements in electro-magnets." E. Ducretet. September 30th. (Complete.)

19,509. "Improvements in electric cables." K. T. Bennet and J. T. Johansson." (Date applied for under Patents, &c., Act 1883, Sec. 103, March 29th, 1901, being date of application in Sweden.) September 30th. (Complete.)

19,510. "Improvements in electric cables." K. T. Bennet and J. T. Johansson. (Date applied for under Patents, &c., Act 1883, Sec. 103, March 29th, 1901, being date of application in Sweden.) September 30th. (Complete.)

19,514. "Improvements in electro-magnetic apparatus giving vibratory or oscillating motion." E. Thompson. October 1st.

19,515. "Improved means for actuating telephone exchange indicators." E. Thompson. October 1st.

19,538. "Hermetically closed, underground conduit for electric tramways and the like, with motor driven collector." F. Janecek. October 1st. (Complete.)

19,546. "An improvement in the fittings of connection boxes for single, concentric and triple concentric electric cables." C. Beckingsale. October 1st.

19,554. "Improvements in overhead electric fittings." P. T. J. Estler. October 1st.

19,588. "Improvements in differential arc lamps." J. Imray. (Société Industrielle des Téléphones, France.) October 1st.

19,590. "Improvements in or connected with the generation of power and with the conductors for electrical distribution." K. J. McMullen and J. A. McMullen. October 1st.

19,604. "Improvements in collectors for electric railways and tramways on the overhead conductor system." J. G. W. Aldridge. October 1st.

19,657. "Improvements in mechanism or devices for communicating step-by-step motions, for controlling, and for encasing, and mounting electric switches." W. Kingsland. October 2nd.

19,686. "Improvements in electric arc rupturing devices." S. H. Short. October 2nd.

19,702. "Improvements in electrical switches." A. H. Gibbings. October 3rd.

19,748. "Improvements relating to electric meters." C. R. Loubery and C. F. Baudry. October 3rd.

19,757. "A new or improved method of controlling electric arc lamps." F. M. Lewis. October 3rd.

19,761. "Improvements relating to underground conductors for telephones, telegraphs or the like." C. V. Somssich. October 3rd. (Complete.)

19,764. "Improvements in dynamo-electric machines." H. M. Hobart. October 3rd.

19,770. "Improvements in electrical demand indicators." E. Dubois. October 3rd.

19,772. "Improvements in telephone exchange systems." The Thomson-Davis Telephone System, Limited, and A. T. M. Thomson. October 3rd.

19,793. "Improvements in electric switches." C. Potts and P. C. Potts. October 4th.

19,795. "Improvements in trolley heads for electrical overhead traction." A. E. Rooke and G. Spencer. October 4th.

19,797. "Electric light extinguisher." C. H. Verity. October 4th.

19,811. "Improvements in apparatus for testing the insulation of electric cables and the like." E. A. Claremont. October 4th.

19,816. "Electric heating apparatus." A. M. Klitz. October 4th.

19,828. "Improvements relating to the track construction of electric railways operated on the conduit system." W. Chapman. October 4th.

19,829. "Improvements relating to the track construction of electric railways or tramways operated on the conduit system." W. Chapman. October 4th.

19,846. "Improvements in or connected with electric traction." T. I Newton. October 4th.

19,864. "Improvements in or connected with the trolley wheels used in overhead electrical traction." R. L. Ross. October 5th.

19,878. "Improvements in electric meters." H. S. Hatfield. October 5th.

19,900. "Trolley wheel guide for electric tramcars and the like." W. Crookell. October 5th.

19,928. "An automatic device for controlling the power of motors of vehicles propelled electrically." W. E. Evans. (Allgemeine Elektricitäts Gesellschaft, Germany.) October 5th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

25,053. "Improvements in connecting pieces for electrical conductors." T. R. Sowerbutts. Dated December 18th, 1899. A connecting piece for connecting branch to main cables is formed by stamping a blank out of sheet metal. One portion is bent to form a socket, the limbs forming clips. The connection is finally soldered. 3 claims.

25,346. "Improvements in perforators for use in connection with automatic telegraph transmittors." A. S. Frampton and F. L. Muirhead. Dated December 21st, 1899. Relates to improvements in the class of instruments described in Specification No. 2,904, A.D., 1897, the key levers being arranged below the surface of the case. The acting portions of the levers are brought up through an opening in the case, and are so bent as to form a vertical series, of which the upper and lower representing the signal keys can co-act with the central or spacing punch, which can act by itself. 3 claims.

25,353. "Improvements in liquid resistances for electrical circuits." E. F. Moy, P. H. Bastie and E. F. Moy, Limited. Dated December 21st, 1899. A liquid resistance is contained in a vessel in which an earthenware insulating-tube descends from a flange nearly to the bottom, and a tubular lead electrode is suspended adjustably above a conical electrode. The conical electrode is cast with a connecting strip which passes out between the vessel and the tube, through a slot in the flange, and carries a terminal. The tubular electrode is cast with a bridge and connecting-bar in which a brass strengthening-rod is enclosed, and which is provided with an insulating pulley and a terminal. 1 claim.

25,362. "Improved method of telegraphing on telephone lines and telegraphic recorders for use in connection therewith." W. P. Thompson. Dated December 21st, 1899. Relates to the use by a telephone subscriber of the lines for sending or receiving telegraph messages. 8 claims.

25,396. "Improvements in electrically-propelled vehicles and in permanent way therefor." A. St. V. Burnaby. Dated December 22nd, 1899. Relates to electrically-propelled vehicles running on a single rail with an overhead guide-rail. 7 claims.

25,403. "An improved electric low-water alarm for steam generators." S. M. Mathews. Dated December 22nd, 1899. Alarms, low-water. The expansion of air in the diaphragm chamber due to the admission of steam in place of water to another chamber when the water level falls below the point of attachment of the apparatus, causes the diaphragm to make contact with the end of a screw and thus complete the circuit of an electric bell. The apparatus is combined with a "try-cock." 2 claims.

25,423. "Improvements in electrical resistances." J. Dulait and O. Garbo. Dated December 22nd, 1899. Iron and insulating strips are coiled together spirally, and at the same time given a channel form, by passage between suitably-shaped rollers. A rigid disc is thus produced. It is mounted on a micanite ring, placed on two metal discs, which are riveted together under pressure. An iron strip is passed round the disc and hooked through holes in terminal block. Such resistances are secured on a supporting tube by clamping nuts. 4 claims.

25,447. "Improvements connected with brakes for electric railway vehicles and the like." British Thomson-Houston Company. (F. E. Case.) Dated December 22nd, 1899. Relates to electrically-actuated brakes, especially for electric railway vehicles and the like. 7 claims.